3-H
DIFFUSER PREDESIGN

FINAL
ENVIRONMENTAL
IMPACT STATEMENT

Brightwater
Regional Wastewater
Treatment System

APPENDICES

Brightwater
TREATMENT SYSTEM

Final

Appendix 3-H
Diffuser Predesign

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King County
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1.0 INTRODUCTION

King County has prepared a Draft Environmental Impact Statement (Draft EIS) (King County, 2002a) and Final Environmental Impact Statement (Final EIS) on the Brightwater Regional Wastewater Treatment System. The Final EIS is intended to provide decision-makers, regulatory agencies and the public with information regarding the probable significant adverse impacts of the Brightwater proposal and identify alternatives and reasonable mitigation measures.

King County Executive Ron Sims has identified a preferred alternative, which is outlined in the Final EIS. This preferred alternative is for public information only, and is not intended in any way to prejudge the County's final decision, which will be made following the issuance of the Final EIS with accompanying technical appendices, comments on the Draft EIS and responses from King County, and additional supporting information. After issuance of the Final EIS, the King County Executive will select final locations for a treatment plant, marine outfall and associated conveyances.

The County Executive authorized the preparation of a set of Technical Reports, in support of the Final EIS. These reports represent a substantial volume of additional investigation on the identified Brightwater alternatives, as appropriate, to identify probable significant adverse environmental impacts as required by the State Environmental Policy Act (SEPA). The collection of pertinent information and evaluation of impacts and mitigation measures on the Brightwater proposal is an ongoing process. The Final EIS incorporates this updated information and additional analysis of the probable significant adverse environmental impacts of the Brightwater alternatives, along with identification of reasonable mitigation measures. Additional evaluation will continue as part of meeting federal, state and local permitting requirements.

Thus, the readers of this Technical Report should take into account the preliminary nature of the data contained herein, as well as the fact that new information relating to Brightwater may become available as the permit process gets underway. It is released at this time as part of King County's commitment to share information with the public as it is being developed.

2.0 PURPOSE

The objective of this Technical Memorandum is to assess available diffuser design information and analyses for the Brightwater Marine Outfall in order to recommend diffuser characteristics, such as length and location, that will meet design and performance criteria identified by King County, Washington Department of Ecology (Ecology) *Criteria for Sewage Works Design* (Ecology, 1998), and best professional practice. Diffuser port configuration (size, number, and spacing) and other diffuser design details will be determined during further outfall predesign based upon analyses utilizing the location and length recommended herein. Project objectives are met by updated diffuser design analyses, environmental studies performed in support of the Draft EIS, and site-specific bathymetry and geophysical surveys performed as part of the outfall predesign. The complete analysis includes effluent plume dilution and trapping depth, diffuser hydraulic performance, and means of protection of the diffuser segment during potential seismic events and submarine slides. Other outfall design and construction details, such as the number of pipelines, pipeline material and size, and construction methods are the subject of separate Technical Memoranda.

3.0 BACKGROUND, ASSUMPTIONS, AND FUTURE ANALYSIS

3.1. Background Diffuser Design Information

Potential outfall and diffuser locations, called zones, are as discussed in the Draft EIS (King County, 2002a). Zone 6 is the preferred outfall zone alternative for the proposed Unocal treatment plant site, and Zone 7S is the preferred outfall zone alternative for the proposed Route 9 treatment plant site. Potential outfall alignments in Zones 6 and 7S developed during conceptual design are shown in Figures 1 and 2, respectively. Potential diffuser sites were identified at depths greater than –550 feet mean lower low water (MLLW).

Previous diffuser design analyses, updated in this Technical Memorandum, were presented in the Brightwater Marine Outfall Conceptual Design Report (King County, 2002b). Marine outfall siting studies, including the *Phase 3 Initial Dilution Assessment of Potential Diffuser Zones* (King County, 2002c), Phase 3 Brightwater Outfall Siting Water Quality Investigation (King County, 2002d), and *Brightwater Marine Outfall Puget Sound Marine Modeling Report* (King County, 2002e), performed during the siting and conceptual design phases (Phases 1, 2, and 3) of the marine outfall are also summarized in this Technical Memorandum. The reader is referred to these documents for a full description of the outfall conceptual design and environmental siting studies.

The documents summarized below present analyses performed using an assumed diffuser port configuration over a range of preliminary diffuser design information, such as depth, length, and design flows. The documents were intended to bracket the performance range of feasible design alternatives, rather than evaluate specific diffuser designs. As such, the analysis in these documents is not at the level of detail required for final design of the diffuser. However, the range of diffuser lengths and depths evaluated is sufficient to recommend a preferred diffuser length and location that will meet the identified diffuser design and performance criteria. Further diffuser analysis (see Section 3.2) will be performed during predesign and based upon the recommended diffuser length and location presented in this Technical Memorandum.

3.1.1. Conceptual Design Report

The objectives of Conceptual Design were (1) the development of several feasible outfall pipeline alignments for discharge of treated effluent from the proposed Brightwater Wastewater Treatment Plant into Puget Sound, and (2) the evaluation of applicable construction methods for installation of the outfall pipeline. Pipeline alignments were developed for outfall zones, identified in the marine outfall siting environmental studies and screening process, that would minimize effluent discharge effects on biological resources and shoreline public use, facilitate the ease of outfall construction, and increase service life of the outfall pipeline by avoidance of underwater areas exhibiting potential for seabed landslides and sloughing.

Conceptual diffuser design evaluated hydraulic performance of the outfall pipeline and diffuser, construction methods and materials, and preliminary diffuser port configurations over a range of feasible diffuser lengths. A depth of the diffuser was assumed in each zone based on preliminary bathymetric surveys over a large area of potential diffuser locations. Potential diffuser configurations (port size and spacing) were selected based on King County's South Treatment Plant outfall and preliminary modeling, which showed that hydraulic parameters recommended in Ecology's *Criteria for Sewage Works Design* (Ecology, 1998) could be met over a wide range of potential Brightwater System flows and diffuser design lengths.

3.1.2. Marine Outfall Siting Environmental Studies

3.1.2.1. Phase 3 Initial Dilution Assessment of Potential Diffuser Zones

The UM3 module of the Environmental Protection Agency's (EPA) Visual Plumes (Frick et al., 2001) was used to estimate plume rise and dilutions at the edge of Ecology authorized acute and chronic mixing zones. Model runs were performed for a range of Brightwater System flows, ambient conditions (stratification and current speed), and diffuser lengths in each of the outfall zones. The sensitivity of the model predictions to variations in diffuser length and port spacing was also investigated. The results show that dilution is most sensitive to ambient current speed, plant discharge, and ambient stratification.

Modeled flows used in the Phase 3 analysis do not correspond directly to the current design flows (see Table 4). However, Tables 1 and 2 present model results based on flows equal to or greater than the current design flows. The results presented in Tables 1 and 2 assume worst-case ambient conditions, which are anticipated to be infrequent events occurring less than once every 20 years. Additional modeling studies (see Section 3.2) will address the probability of dilution and effluent transport performance at different flow rate and ambient conditions.

The dilution modeling results are summarized in Table 1 for several diffuser length alternatives and Brightwater System capacities. Model runs were performed at critical ambient current speeds and density stratification. Modeled dilution at the acute and chronic mixing zone boundaries correspond to peak hour and maximum month flows, respectively, at the different stages of Brightwater development.

Table 1. Near-Field Dilution Model Results – Minimum Predicted Dilution

	Initial Capacity		Plant Saturation		Plant Saturation (Edmonds/Lynnwood Flow Alternative)	
Diffuser Alternative	Acute[a]	Chronic[b]	Acute[a]	Chronic[b]	Acute[a]	Chronic[b]
600 ft depth, 250 ft length	84	271	51	263	34	198
600 ft depth, 500 ft length	133	367	89	342	58	274
600 ft depth, 750 ft length	168	451	123	403	81	325

[a] Peak Hour Flow
[b] Maximum Month Flow

One of the diffuser performance criteria identified by Ecology is that the diffuser should achieve a minimum dilution of 100:1 at the chronic mixing zone boundary at maximum month flow and 30:1 at the acute mixing zone boundary at peak instantaneous flow. The minimum dilutions reported in Table 1 show that diffusers 250 feet in length or greater would meet this criterion at both alternative outfall Zones 6 and 7S for the expected range of Brightwater System flows.

Model runs for plume submergence were performed for various flow, diffuser depth, diffuser length, and stratification conditions. Model results are summarized in Table 2 for a diffuser depth of 600 feet at Brightwater System flows corresponding to maximum month wet season flows at plant capacity (45 mgd at the initial plant capacity, 68 mgd after plant expansion, and 90 mgd for the sub-alternative combining Lynnwood and Edmonds flows with Brightwater). Analyses were performed at both summer and winter stratification conditions. Winter and summer conditions represent the range of the observed ambient stratification. Effluent plume submergence during both spring and fall conditions is greater than for winter conditions, but less than for summer conditions.

Table 2. Effluent Plume Submergence Results (Maximum Month Flow)

Diffuser Length (ft)	Diffuser Depth (ft)	Minimum Submergence (ft) (Max Month Flow 45 mgd)		Minimum Submergence (ft) (Max Month Flow 68 mgd)		Minimum Submergence (ft) (Max Month Flow 90 mgd)	
		Winter Stratification	Summer Stratification	Winter Stratification	Summer Stratification	Winter Stratification	Summer Stratification
250	600	66	305	20	256	5	236
500	600	151	361	105	331	66	305
750	600	194	387	151	361	118	341

Submergence, the depth below the water surface at which the effluent plume ceases to rise, was evaluated at maximum month wet season flows to be consistent with Washington Department of Health shellfish closure zone analyses (see Section 4.2). Model runs over a range of diffuser depth and length indicate that a minimum diffuser length of 400 feet is required to maintain a submergence of 70 feet at maximum wet-weather flows and a diffuser depth of –600 feet MLLW[1].

Modeling presented in the *Phase 3 Initial Dilution Assessment of Potential Diffuser Zones* includes both near-field (jet-momentum dissipation) and far-field (receiving water turbulence) dilution. Modeling that addresses background concentrations and the potential impact of effluent reflux was evaluated in the *Brightwater Marine Outfall Puget Sound Marine Modeling Report* (see Section 3.1.2.3).

3.1.2.2. Phase 3 Water Quality Investigation

To evaluate potential environmental impacts from a future Brightwater effluent discharge, current and future chemical concentrations in the Puget Sound were assessed for their potential to impact human health and aquatic life. Using a risk-based approach, aquatic life exposure concentrations and human health doses were compared with relevant toxicity guideline values to identify potential risks to aquatic life, and the potential for cancer and noncancer effects that occur in people recreating at study area locations within the Puget Sound.

Current potential cancer risks and noncancer hazards estimated for people recreating at nearshore locations within the study area were within or below generally acceptable levels regardless of diffuser placement location in outfall Zones 6 and 7S. The majority of human health risks were associated with exposure to ambient levels of arsenic. Given the overwhelming contribution of ambient levels of arsenic to the overall cancer and noncancer risk estimates, there is no significant difference in the risk estimates for current versus future (including treatment plant operation) scenarios.

Risks to aquatic life were evaluated in three exposure locations within each of the candidate outfall zones; the mixing zone, the near bottom area, and the intertidal nearshore. In general, current and future potential risks to water column and benthic aquatic life in each exposure location were negligible. Although not detected above the method detection limit (MDL) of analytical equipment, the estimated risks to the water column or sediment from three chemicals

[1] Selection of the Edmonds/Lynnwood flow sub-alternative would require a longer diffuser to maintain a trapping depth below 70 feet at all flows and stratification conditions.

(chlorpyrifos, 4,4¢-DDT, and 2,4-dichlorophenol) were uncertain. These chemicals were never detected in ambient water and concentrations detected in the effluent would not exceed toxicity thresholds when divided by the appropriate dilution factor. However, because the MDL values are sufficiently greater than the corresponding toxicity thresholds, risks are uncertain.

Potential exposure to microorganisms was estimated and compared to federal and state water quality standards. Measured concentrations of microorganisms were divided by the lowest (worst case) modeled initial dilution achieved at the edge of the acute regulatory mixing zone for any outfall zone/outfall configuration (see Table 1). Even at worst case dilution, there should be no significant risk of exposure to effluent-associated fecal coliform while either swimming or digging in the sand near the water. Based on federal and state water quality standards, risks from other microorganisms are also expected to be low.

Potential for reduction of dissolved oxygen (DO) concentrations in the receiving water resulting from the effluent discharge was estimated assuming high effluent flow conditions and low natural DO concentrations. Impacts to DO concentrations were estimated for both the increase in biological oxygen demand (BOD) and the influence of increased phytoplankton growth due to nutrients in the effluent discharge. Combining the DO demand impacts from these two sources results in a maximum reduction of 0.130 mg/L, which is below the 0.2 mg/L allowed by state standards.

3.1.2.3. Marine Modeling Report

The circulation model of Puget Sound was based on the Princeton Ocean Model (POM), which has an extensive history of use for modeling of estuaries, coastal regions, and open oceans. The Puget Sound model extends into the Strait of Juan de Fuca as far as the southern tip of Vancouver Island. A number of modifications were made to the POM to simulate processes important within Puget Sound.

The model was used to predict effluent advection and dispersion under summer and winter scenarios for each of the outfall zones. The model simulated an effluent discharge at the bottom of Puget Sound and traced the effluent for a 10-day period. The minimum dilution was predicted at 11 shoreline locations corresponding to popular human use sites. Similarly, the model was used to predict minimum dilution at the bottom of Puget Sound. These dilution values were combined with a separate estimate of the long-term dilution to estimate the potential additional contribution of the proposed outfall toward the concentration of conservative substances within Puget Sound.

The model predicted that the discharged effluent plume would generally remain in the lower portion of the water column and that very low concentrations would reach shoreline locations within 10 days. Including the long-term accumulation of effluent in Puget Sound, dilutions of no less than one part effluent in 1,750 parts per water (1,750:1) were predicted to reach shoreline locations. The long-term accumulation dilution near the seafloor, where the effluent plume comes in contact with the bottom, was predicted at more than 340:1.

3.2. Future Diffuser Analysis

Environmental studies summarized in Section 3.1 evaluated the performance range of feasible design alternatives to support development of the Draft EIS. The studies indicate that a range of diffuser lengths, locations, and port configurations could be selected to meet diffuser design and performance criteria. Additional diffuser modeling studies of specific diffuser lengths and locations is required to evaluate diffuser performance and the ability to meet diffuser criteria.

Diffuser modeling studies performed to update the studies cited in Section 3.1 based upon current treatment plant processes and diffuser depth and location recommended in this Technical Memorandum include the *Predesign Initial Dilution Assessment* (King County, 2003a) and *Effluent Quality Evaluation: Membrane Bioreactor and Advanced Primary System* (King County, 2003b). These additional studies also evaluate the probability of dilution and effluent transport performance at different flow rate and ambient conditions.

As determined by the dilution modeling completed to date, dilution and effluent transport are fairly insensitive to diffuser port configuration. Therefore, design of the specific diffuser port configuration is not significant to the impact analysis to be presented in the Final EIS. Diffuser port configuration and final diffuser design will be part of the Brightwater Predesign Report to be completed after issuance of the Final EIS.

4.0 DIFFUSER DESIGN CRITERIA

Marine outfalls typically terminate in multiport diffusers that promote rapid dilution of effluent with ambient marine waters. Upon discharge, the momentum of effluent exiting diffuser ports results in vigorous mixing with ambient seawater. As this "jet-momentum" starts to dissipate, the buoyancy of the effluent provides further mixing as the plume rises through the water column due to a difference in plume and receiving water density. When the receiving water column is density stratified, sufficient dilution may occur at a depth such that the diluted effluent becomes denser than the overlying surface water and is subsequently trapped below the surface. When the plume traps, initial mixing is completed. The diluted effluent then forms a waste field around this trapping depth, which is then spread and advected laterally by currents and eddies generated by wind, tides, estuarine transport mechanisms, and bathymetric features.

The dilution and effluent transport criteria identified by King County for the Brightwater Marine Outfall include the following:

- Achieve minimum dilution of 100:1 at the chronic mixing zone boundary at maximum month flow and 30:1 at the acute mixing zone boundary at peak instantaneous flow.
- Maintain trapping depth below –70 feet MLLW at maximum month flow.
- Minimize potential for effluent reflux, contact with human receptors, contact with fisheries and other aquatic habitat, and contact with the shoreline.
- Meet Washington State Marine Water Quality Criteria for protection of aquatic and human health.

Other operational and maintenance criteria include:

- Protect diffuser from potential seismic events and submarine slides.
- Maintain acceptable hydraulic performance at all Brightwater System flows.
- Minimize need to access diffuser for maintenance.

A brief discussion for each of these design goals is discussed below.

4.1. Dilution at Acute and Chronic Mixing Zone Boundaries

Diffuser design characteristics will be selected to meet dilution criteria identified by Ecology in *Criteria for Sewage Works Design* (Ecology, 1998). The diffuser will achieve a minimum dilution of 100:1 during maximum month flow at the chronic mixing zone boundary and 30:1 during peak instantaneous flow at the acute mixing zone boundary. The chronic mixing zone boundary is a cylindrical volume located a horizontal distance of 200 feet plus the diffuser axis depth from each discharge port. The acute mixing zone boundary is a cylindrical volume located at a distance equal to 10 percent of the chronic distance from each diffuser port.

The minimum dilutions modeled in the *Phase 3 Initial Dilution Assessment of Potential Diffuser Zones* (King County, 2002c) and reported in Table 1 show that diffusers 250 feet in length or greater would meet dilution criterion at both alternative outfall Zones 6 and 7S for a range of Brightwater System flows and ambient conditions.

4.2. Trapping Depth

The desired trapping depth, the point at which diluted effluent reaches neutral buoyancy with the surrounding surface water, is –70 feet MLLW at projected maximum month wet season flows. Washington Department of Health (DOH) uses this flow projection in their shellfish closure zone analyses. A trapping depth of –70 feet MLLW will be protective of the most dense plant and animal habitat present in the sensitive nearshore area of Puget Sound (see Figure 3) and would ensure that Washington Department of Fish and Wildlife (WDFW) and Washington Department of Natural Resources (WDNR) managed commercial geoduck harvesting beds would not be impacted by the effluent plume. Trapping at depth will also minimize potential for human contact with the effluent plume.

The predicted submergence based on model runs presented in the *Phase 3 Initial Dilution Assessment of Potential Diffuser Zones* (King County, 2002c) indicates that diffusers 400 feet in length or greater would meet trapping depth goals for maximum wet weather flows at anticipated diffuser depths of –600 feet MLLW or greater. Trapping depth goals may not be met at winter stratification conditions if a shorter diffuser or less deep diffuser location were selected.

4.3. Effluent Reflux, Contact with Human Receptors, and Contact with Aquatic Habitat

The cycle of ebb and flood tidal currents can cause effluent to accumulate in the receiving water surrounding an outfall. This effluent reflux would be expected to lower long-term dilution of effluent discharge, as predicted from initial dilution models. Various methods are available to account for the accumulation of effluent when determining potential to exceed water quality criteria. The *Permit Writer's Manual* (Ecology, 2002) recommends a default dilution ratio correction of 0.5 (critical dilution ratios are reduced by a factor of 2). However the bulk of the plume dilution occurs at depth, below the trapped effluent plume or wastefield, due to the strong ambient density stratification, large source of dilution water, and strong plume buoyancy effects present at the Brightwater outfall zones. Thus, the correction is believed not warranted for the analyses presented in this Technical Memorandum. As discussed in the *Marine Modeling Report* (King County, 2002e), and based on candidate diffuser locations, the long-term dilution of effluent in Puget Sound is no less than 1,750:1 at the shoreline and 340:1 at the seafloor. These model predictions show that the proposed effluent discharges have very high levels of dilution and that the impact of effluent reflux is not significant at any of the candidate diffuser locations. As described previously in Section 3.1.2.2, a trapping depth of –70 feet MLLW would minimize the potential for discharged effluent to come in contact with human receptors and aquatic habitat.

4.4. Washington State Marine Water Quality Criteria

In accordance with the Clean Water Act, the State of Washington has set water quality standards to protect the beneficial uses of surface waters. The standards vary with classification of the surface water body (Chapter 173-201A WAC). Ecology assigns the classifications, which include AA (extraordinary), A (excellent), B (good), C (fair), and Lake Class. The marine waters of Puget Sound in the vicinity of alternative outfall Zones 6 and 7S are designated as Class AA. For Class AA fresh and marine waters, water quality standards have been established for fecal coliform bacteria (an indicator of sewage and animal waste); dissolved oxygen; total dissolved gas; temperature; pH; turbidity; aesthetics; and toxic, radioactive, and deleterious material (including metals and ammonia). The narrative and numeric aquatic life water quality standards for Class AA marine waters presented in Table 3 must be protected at the chronic mixing zone boundary, as stated in Ecology's *Permit Writers Manual* (Ecology, 2002).

Table 3. Washington State Water Quality Standards for Class AA Marine Waters (WAC 173-201[A]) Analysis (Heading 1)

General Characteristics and Uses	Narrative and Numeric Water Quality Criteria
Water quality of this class shall markedly and uniformly exceed the requirements for all or substantially all uses. Characteristic uses shall include: • Water supply (domestic, industrial, and agricultural). • Stock watering. • Fish and shellfish. • Wildlife habitat. • Recreation (primary contact recreation, sport fishing, boating, and aesthetic enjoyment). • Commerce and navigation.	<u>Fecal Coliform Bacteria</u>: Shall not exceed a geometric mean value of 14 colonies per 100 ml and shall not have more than 10 percent of all samples obtained for calculating the geometric mean exceeding 43 colonies per 100 ml. <u>Dissolved Oxygen</u>: Shall exceed 7.0 mg/L except when natural conditions such as upwelling occurs, causing the dissolved oxygen to be depressed near or below 7.0 mg/L. Natural dissolved oxygen levels may be degraded by up to 0.2 mg/L by human-caused activities. <u>Temperatures</u>: Shall not exceed 13.0°C due to human activities. When natural conditions exceed 13.0°C, no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3°C. Incremental temperature increases resulting from point source activities shall not, at any time, exceed at the mixing zone boundary, 8 ÷ (background temperature – 4°C). <u>pH</u>: Shall be within the range of 7.0 to 8.5 with a human-caused variation within the above range of less than 0.2 units. <u>Turbidity</u>: Shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU. Toxic, radioactive, or deleterious material concentrations shall be below those that have the potential, either singularly or cumulatively, to adversely affect characteristic uses, adversely affect public health, or cause acute or chronic conditions to the most sensitive biota dependent upon those waters. Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

4.5. Diffuser Protection

The potential for diffuser burial due to sloughing of the side-slopes and liquefaction during potential seismic activity may impact selection of diffuser location. Preliminary bathymetry and geophysical surveys completed during conceptual design indicated relatively steep slopes and potential slope failures within both Zones 6 and 7S. The diffuser will be located offshore, beyond these areas of anticipated failure. Site specific bathymetric surveys completed during continuing predesign work are utilized in this Technical Memorandum to locate diffusers in areas with minimal burial risk.

4.6. Hydraulic Performance

Diffuser design characteristics will be selected to best achieve the following flow and performance objectives identified by Ecology in the *Criteria for Sewage Works Design* (Ecology, 1998):

- Minimum port velocity of 2 to 3 feet per second at peak flow.
- Maximum port velocity should rarely exceed 15 feet per second.
- Across port flow variation of less than 20 percent under normal diffuser operating flow range.
- Minimize saltwater intrusion (Froude number greater than one for each port).
- Minimize friction head loss.

A properly functioning outfall and diffuser, meeting the performance objectives above, will minimize the potential for the deposition and accumulation of solids in the diffuser, reduce pumping costs (if any), reduce maintenance requirements by limiting corrosion and biofouling of the diffuser ports and pipeline, and ensure that modeled dilution and effluent transport are achieved.

Hydraulic analysis of potential diffuser configurations was performed during conceptual design using an iterative process developed in *Diffusers for Disposal of Sewage in Sea Water* (Rawn et al., 1960). The diffuser model projects port flow distribution, diffuser head loss, and other operating characteristics based on flow, length, and diffuser port configuration. The hydraulic analyses, presented in the *Brightwater Marine Outfall Conceptual Design Report* (King County, 2002b), is updated in Section 5.

4.7. Diffuser Maintenance

The marine outfall and diffuser will be designed for automatic operation. However, outfall pipelines, diffusers, and access portals would require periodic maintenance to evaluate structural integrity and hydraulic performance. Design features of the diffuser that will minimize maintenance requirements and maintain proper operation over its design life may include:

- Check valves.
- Self-cleaning end port.
- Diffuser port risers.
- Anti-fouling and corrosion resistant materials.

The diffuser would be designed to maintain proper hydraulic performance of the diffuser over the range of Brightwater System flows. Meeting performance criteria for flow velocity and flow distribution along the diffuser axis will aid maintenance efforts by minimizing sediment accumulation and seawater intrusion. Diffuser maintenance is further discussed in Sections 5 and 6.

5.0 ANALYSES

Diffuser design and construction analyses herein were used along with the marine outfall siting studies Phase 3 environmental and modeling analyses to recommend diffuser characteristics that will meet design criteria identified by King County. Diffuser design was evaluated with respect to the following analyses, discussed individually in the following sections:

- Evaluation of Outfall Pipeline Alignments.
- Bathymetric Survey.
- Geotechnical/Geophysical Explorations.
- Cable Search Survey.
- Brightwater System Flows.
- Effluent Quality and Dilution
- Hydraulic Performance Modeling.
- Evaluation of Outfall Pipeline Construction Methods and Materials.
- Review of Existing King County Diffuser Maintenance Reports.

The hydraulic and dilution analyses utilize an assumed diffuser port configuration based on King County's existing South Treatment Plant Outfall. The assumed configuration meets established performance criteria and serves as a benchmark for further analyses. Diffuser modeling and analyses of specific port configurations, using the diffuser lengths and locations recommended herein, will be performed as part of continuing predesign efforts.

5.1. Evaluation of Outfall Pipeline Alignments

The outfall alignments shown in Figures 1 and 2 were based on the preliminary bathymetric surveys and conceptual design analysis. These conceptual alignments differ based on the start point of the marine outfall and the potential nearshore construction method. Potential alignments and nearshore construction methods are discussed in detail in the *Nearshore Construction Method and Alignment Alternatives Technical Memorandum* (King County, 2003c).

In general, the alignments strive to cross bathymetric contour lines approximately at right angles (perpendicular), especially when traversing the steepest slopes between the nearshore areas and the relatively flat area of the Puget Sound main channel. Orientation of the outfall pipeline perpendicular to bathymetric contours minimizes the soil loading imposed on the pipeline during potential submarine slides. Where possible, outfall alignments are also routed around known nearshore environmental resources or human use areas.

Alignments within Zone 7S must cross a trough reaching water depths up to –710 feet MLLW, located approximately between 3,000 and 4,000 feet offshore of the tip of Point Wells, before reaching a suitable diffuser location. As a result of crossing the trough, a low point would be created in the outfall pipeline. This low point is not anticipated to impact the structural or hydraulic performance of the outfall and diffuser nor impact maintenance requirements for the outfall pipeline.

A diffuser would be located at the end of the offshore outfall pipeline segment and preferably in gently sloping areas in order to distribute effluent flow equally over the entire diffuser axis. Profiles, including recommended diffuser locations, for each of the potential outfall alignments are presented in Figures 4 through 7.

The updated bathymetric survey data discussed in Section 5.2 does not indicate that a change in the outfall alignments is required. Favorable diffuser locations of sufficient length are available at the end of each potential outfall alignment. Analysis in this report assumes that each outfall alignment is viable. However, outfall alignments may be modified based on continuing predesign and design analyses, and collection of more site specific information.

5.2. Bathymetric Survey

A detailed bathymetric survey (February 25 through February 28, 2003) was completed for outfall Zones 6 and 7S to update the preliminary survey conducted during conceptual design and reported in the *Marine Geophysical Investigation: Marine Outfall Siting Study* (King County, 2001). Figures 8 and 9 present the bathymetric contours within alternative Zones 6 and 7S, respectively. Detailed description of the survey method, survey equipment, and its accuracy/resolution is provided in the *Marine Survey Report* (King County, 2003d, Pending).

The nearshore shelf of Zone 6 extends approximately 1,000 feet offshore. Beyond the shelf, the average seafloor sideslope increases to approximately 15 percent, with a maximum of approximately 20 percent. The sloped seafloor transitions to the main channel of Puget Sound approximately 5,000 feet offshore at a water depth of approximately –600 feet MLLW. Generally, flat diffuser areas are located between 5,000 and 7,500 feet offshore at water depths of approximately –600 feet MLLW.

The nearshore shelf of Zone 7S extends between 500 and 2,000 feet offshore. Beyond the shelf, the average seafloor sideslope increases to approximately 25 percent, with a maximum of approximately 30 to 35 percent. The sloped seafloor transitions to the main channel of Puget Sound approximately 4,000 feet offshore at a water depth of approximately –700 feet MLLW. From this maximum depth, the seafloor rises gradually (at a slope of 5 to 8 percent) before reaching generally flat diffuser areas located between 5,000 and 7,500 feet offshore at water depths of approximately –600 feet MLLW.

An area approximately 700 feet south of the Richmond Beach alignment, the southernmost alignment in Zone 7S (see Figure 9), seems to indicate the presence of a past submarine slide. The sloughed soils from this potential slide extend approximately 500 feet beyond the toe of the seafloor side slope.

5.3. Geotechnical/Geophysical Explorations

Previous geotechnical and geophysical explorations conducted during conceptual design indicated that potential diffuser locations in both alternative diffuser Zones 6 and 7S are covered by 10 to 20 feet of fine-grained sediments. Along potential outfall alignments in both zones, loose granular medium-grained soils were found overlaying denser glacial/interglacial sediment. Steep submarine slopes mantled with loose, recent granular soils can be susceptible to instability caused by static forces, seismic forces, seismic forces accompanied with liquefaction, and/or construction vibration/disturbance. Deeper soils encountered have a low risk of liquefaction and slope failure.

5.4. Cable Search Survey

Potential outfall alignments may cross known utility cable areas established by the United States Army Corps of Engineers (COE). As part of continuing predesign efforts, a field survey of the project area will be performed to locate and map existing underwater surface and subsurface cables or pipelines. A preliminary desktop investigation into the location of known cables with utility companies, the COE, and the United States Coast Guard will be performed prior to the survey to facilitate field work. Results of the desktop investigation and field survey mapping will be used to determine appropriate design provisions to ensure proper protection of cables, if any, during construction.

Preliminary cable investigations have indicated the presence of an energy cable, operated by Puget Sound Energy, that extends from Richmond Beach to Kingston in the area of outfall Zone 7S. It is believed that the cable is to the south of the proposed outfall alignments, but further investigations will be performed to confirm its location along with other cable locations.

5.5. Brightwater System Flows

Table 4 presents typical Average Dry Weather Flow (ADWF), Average Wet Weather Flow (AWWF), and Peak Flow expected at different stages of the development of the Brightwater System. Potential flows of up to 170 million gallons per day (mgd) are possible at peak flow. A subalternative for the proposed Unocal plant site would add the flows of the Edmonds and Lynnwood treatment plants to the Brightwater System flow after plant expansion. Hydraulic performance model runs were completed for each of the flows identified in Table 4. Brightwater System flow projections may be updated during continuing predesign analyses.

Table 4. Typical Brightwater System Flows

Stage of Development	ADWF (mgd)	AWWF (mgd)	Peak Flow (mgd)
Plant Startup (2010)	18	23	83
Plant Expansion (~2040)	28	36	130
Saturation (~2050)	44	54	170
Brightwater plus Edmonds and Lynwood Flows (~2050)	58	72	235

5.6. Effluent Quality and Dilution

The likelihood for the discharged Brightwater effluent to exceed state water quality standards protective of marine life and human health was evaluated using minimum dilution values at plant saturation (see Table 1) and assumptions for effluent quality based on maximum concentrations measured at King County's South Treatment Plant. The split flow membrane bioreactor (MBR) treatment process proposed for Brightwater is anticipated to produce an effluent with higher average effluent quality than the South Treatment Plant, which utilizes a conventional activated sludge (CAS) process[2] . Table 5 presents assumed effluent quality at discharge and effluent quality at the acute and chronic mixing zone boundaries using minimum dilution factors of 34 and 198 at the acute and chronic mixing zone boundaries, respectively. For comparison, state water quality standards at the acute and chronic mixing zone boundaries are also shown.

[2] A comparison of MBR and CAS effluent quality is presented in the *Effluent Quality Evaluation: Membrane Bioreactor and Advanced Primary System* (King County, 2003b).

Table 5. Effluent Quality at the Acute and Chronic Mixing Zone Boundaries

Parameter	Discharge Concentration (ug/L)	Acute Mixing Zone Boundary Concentration (ug/L)	Chronic Mixing Zone Boundary Concentration (ug/L)	Water Quality Criteria		
				Marine Life		Human Health
				Acute Mixing Zone Boundary (ug/L)	Chronic Mixing Zone Boundary (ug/L)	Chronic Mixing Zone Boundary (ug/L)
Ammonia	28.00	0.82	0.14	233	35	N/A
Antimony	0.02	0.00	0.00	N/A	N/A	4,300
Arsenic	0.06	0.00	0.00	69	36	0.14
Cadmium	0.00	0.00	0.00	42	9.3	N/A
Chloroform	5.06	0.15	0.03	N/A	N/A	470
Chlorpyrifos	0.02	0.00	0.00	0.011	0.0056	N/A
Chromium	0.01	0.00	0.00	1,100	50	N/A
Copper	0.21	0.01	0.00	4.8	3.1	N/A
Cyanide	0.02	0.00	0.00	1	1	220,000
1,2-Dichlorobenzene	1.03	0.03	0.01	1,970	N/A	17,000
1,4-Dichlorobenzene	3.22	0.09	0.02	1,970	N/A	2,600
1,2-Dichloroethane	2.50	0.07	0.01	113,000	N/A	99
Diethylphthalate	103.00	3.03	0.52	2,944	3.4	120,000
Dimethylphthalate	0.71	0.02	0.00	2,944	3.4	2,900,000
Lead	0.03	0.00	0.00	210	8.1	N/A
Methylene Chloride	25.00	0.74	0.13	N/A	N/A	1,600
Mercury	0.02	0.00	0.00	1.8	0.025	0.15
Nickel	0.02	0.00	0.00	74	8.2	4,600
Pentachlorophenol	0.65	0.02	0.00	13	7.9	8.2
Phenol	13.90	0.41	0.07	5,800	N/A	4,600,000
Silver	0.01	0.00	0.00	1.9	N/A	N/A
Tetrachloroethylene	8.44	0.25	0.04	10,200	450	8.85
Toluene	6.93	0.20	0.04	6,300	5,000	200,000
Zinc	6.93	0.20	0.04	90	81	N/A

Assuming minimum dilution and maximum discharge concentrations, water quality standards are met for all parameters. Although the evaluation summarized in Table 5 is preliminary, the assumptions made are conservative. A Reasonable Potential Analysis will be performed in accordance with Ecology guidelines as part of the permit application process.

5.7. Hydraulic Performance Modeling

Updated hydraulic analysis was performed using an iterative process developed in *Diffusers for Disposal of Sewage in Sea Water* (Rawn et al., 1960). A single 60-inch diffuser pipe segment was assumed for analysis based on anticipated Brightwater System flows and the outfall pipeline hydraulic analysis presented in the Brightwater Marine Outfall Conceptual Design Report (King

County, 2002b). A single 66-inch pipe segment was assumed for the Unocal subalternative including Edmonds and Lynnwood flows. Analysis also assumed a diffuser port configuration based on King County's existing South Treatment Plant Outfall, which includes diffuser segments with 168 evenly spaced 4-inch ports. This port configuration was also assumed in effluent dilution and transport model runs (King County, 2002c). Other diffuser design assumptions include:

- Seafloor slope at diffuser location is negligible.
- Risers not included in diffuser model.
- Brightwater System flow ranges between 18 and 235 mgd (Table 4).

The diffuser model was used to project port flow velocity, port flow distribution, diffuser head loss, and the Froude Number with varying Brightwater System flow and diffuser length. Model runs were performed at each flow presented in Table 4 and diffuser lengths between 250 and 750 feet (at 50-foot increments). The model results were evaluated based on the hydraulic performance criteria discussed in Section 4.6. An example model spreadsheet is provided in Appendix A.

5.7.1. Froude Number

Since seawater is typically heavier than effluent by about 2 percent in Puget Sound, the seawater will intrude into the diffuser ports unless the discharge velocity is sufficient to overcome its increased weight (density head). Seawater intrusion should be minimized because it can result in reduced hydraulic capacity, reduced dilution efficiency of the diffuser, and premature pipeline corrosion (Ecology, 1998). Intrusion can be avoided by assuring that the Froude Number (defined as the ratio between port velocity and the relative density difference between discharged and marine waters) is greater than one for all diffuser ports.

Model runs predict that at all flows and diffuser lengths the Froude Number would be greater than 1. The Froude Number increases with increasing flows and diffuser length, from a minimum of approximately 3 to a maximum of 37. The Froude Number results indicate that seawater intrusion through the diffuser ports is not anticipated at flows greater than 18 mgd. It is assumed that effluent flows less than 18 mgd will occur at plant start up or due to diurnal flow variations. However, the adverse affects of seawater intrusion will be avoided as long as the daily maximum dry weather flow is sufficient to flush seawater from the diffuser (Larsen et al., 1992).

5.7.2. Diffuser Port Velocity

Average port velocities do not vary significantly with diffuser length, assuming the number and diameter of ports remains constant. However, port velocity does increase with increasing flow. Table 6 presents average port velocity for the modeled Brightwater System flows.

The lower range of port velocities (approximately 2 feet per second) achieves Ecology recommended minimum velocity criteria. Ecology recommendations for maximum port velocity indicate that 15 feet per second should rarely be exceeded. Average port velocity would be greater than 15 feet per second only at flows greater than 130 mgd. Flows greater than 130 mgd would occur at buildout capacity of the Brightwater Treatment Plant and only at infrequent peak flow conditions.

Table 6. Port Velocity versus Brightwater System Flow (168 evenly spaced 4-inch ports)

Brightwater System Flow (mgd)	Port Velocity (feet per second)
18	2.0
23	2.5
28	3.2
36	4.0
44	5.0
54	6.0
83	9.5
130	15.0
170	19.5
235 (Edmonds/Lynnwood sub-alternative only)	25.0

Under the Unocal subalternative, including Edmonds and Lynnwood flows, the peak design flow rate of 235 mgd has an associated port velocity of 25 feet per second. It is anticipated that further refinement of this subalternative could include larger ports with check valves or a design that would allow additional ports to be opened after the Edmonds and Lynnwood flows were combined with Brightwater system flows.

5.7.3. Port Flow Variation

Ecology diffuser design criteria recommend that variation in port velocity from the initial to the final diffuser port should be 20 percent or less. Model results indicate that port flow variation is not significantly impacted by increasing Brightwater System flow under the assumed diffuser configuration. However, modeled port flow variation was impacted by the length of the diffuser, decreasing from approximately 30 percent at a diffuser length of 250 feet to approximately 20 percent at a diffuser length of 750 feet. The variation in port flow could be decreased to meet Ecology criteria by a stepped decrease in diffuser port diameter along the diffuser axis. For example, the first 84 diffuser ports could be enlarged to 5 inches in diameter and the last 84 diffuser ports could remain 4 inches in diameter. Preliminary analysis with this stepped port size approach would indicate that port flow variation could be reduced to 20 percent for a 500-foot diffuser at peak flow. It is anticipated that further refinement of the diffuser port configuration would reduce port flow variation below 20 percent.

5.7.4. Head Loss

Diffuser head loss increases significantly with Brightwater System flow and varies only slightly with diffuser length. Head loss through the diffuser can be minimized by ensuring that other Ecology hydraulic performance criteria are met. Table 7 presents predicted head loss for each of the modeled Brightwater System flows.

Table 7. Diffuser Head Loss versus Brightwater System Flow

Brightwater System Flow (mgd)	Head Loss (ft)
18	0.12
22	0.18
28	0.29
35	0.45
44	0.72
53	1.0
83	2.5
129	6.1
170	10.5
235 (Edmonds/Lynnwood subalternative only)	20.0

The predicted diffuser head losses presented in Table 7 are similar to estimates presented in the Brightwater Marine Outfall Conceptual Design Report (King County, 2002b). A discussion of the total outfall and diffuser head losses are not within the scope of this Technical Memorandum. However, it is anticipated that the predicted diffuser head loss will not limit design flexibility in the upstream outfall pipeline.

5.8. Evaluation of Outfall Pipeline Construction Methods and Materials

The diffuser is likely to be installed in conjunction with the offshore outfall segment. Consequently, diffuser construction methods are dependent on analysis outside the scope of this Technical Memorandum. Similarly, materials utilized in construction of the diffuser segment (excluding potential diffuser port riser materials) are likely to match those of the offshore outfall segment. Selection of the offshore and diffuser segment materials will be discussed in a separate Technical Memorandum.

5.9. Review of Existing King County Diffuser Maintenance Reports

Existing outfall and diffuser maintenance reports completed for King County's South Treatment Plant outfall in Renton, Washington, were reviewed in order to recommend outfall and diffuser design details that may minimize maintenance efforts required over the life of the outfall. Results of the maintenance report review are presented in the *King County Outfall Maintenance and Inspection Report* (King County, 2003e). Check valves are used to prevent seawater intrusion. The valves progressively open as effluent flow increases and remain closed in the absence of effluent flow. Hydraulic analyses in Section 5.7 indicate that check valves would not be required since seawater intrusion was not anticipated at flows greater than 18 mgd. Check valves may be warranted if low flow periods below 18 mgd occur at plant startup or due to increased distribution of reclaimed water.

Blind ports are temporarily capped diffuser ports typically utilized at low flow, startup conditions. Flanges on the blind ports are removed at a later date when sufficient effluent flow is available to prevent seawater intrusion. Use of blind ports at the diffuser depths anticipated for the Brightwater Marine Outfall (greater than –600 feet MLLW) would be complicated by the fact that robotic equipment would be required to remove the flanged caps after initial outfall installation. As discussed for check valves, blind ports may be warranted for potential low flow periods (below 18 mgd). However, due to the difficulty involved with removing blind ports at depth, it is anticipated that check valves would be a more favorable method for preventing seawater intrusion at low flows.

Risers are used to extend those diffuser ports installed directly in the wall of the diffuser pipeline in order to modify the effective slope at which the effluent is discharged and allow for even distribution of port flow along the diffuser axis. Risers also extend the ports to account for long-term sediment accumulation and prevent scour of the seafloor. In general, a seafloor slope of less than 2 percent along a 500-foot diffuser length (elevation change of 10 feet) would not be anticipated to impact the flow distribution and would not require risers. Assuming a diffuser length of 500 feet and a maximum riser height of 10 feet, the diffuser could be installed at a 3 percent slope without impact to flow distribution. Hydraulic analyses in this report assumed that risers would not be required since diffuser locations with little or no slope are available in outfall Zones 6 and 7S. The natural sedimentation of material at the seafloor or settlement of material below the diffuser may necessitate the use of risers to prevent diffuser port burial over the design life of the outfall. Sedimentation and settlement rates will be determined as part of continuing predesign efforts.

Self-cleaning end ports are commonly used in diffuser designs. These ports often have an invert elevation that is the same as the diffuser pipeline and are used as a means of scouring accumulated sediment from the diffuser pipeline during higher flow periods. It is anticipated that a self-cleaning end port would be utilized in the design of the Brightwater Marine Outfall. Detailed design of the end port would be completed during final design.

6.0 CONCLUSION

The updated diffuser design analyses, environmental studies, and site-specific bathymetry discussed in this Technical Memorandum indicate that a range of diffuser lengths, locations, and port configurations could be selected to meet diffuser design goals. However, diffuser installation costs and risk concerns should also be considered in the selection process. Recommended diffuser characteristics selected to provide the most favorable diffuser performance, minimize anticipated installation costs, and reduce risk are discussed in the following sections.

6.1. Diffuser Location

To minimize outfall pipeline material and installation costs, the diffuser segment should be located as close to the shoreline as is allowed by availability of suitable diffuser sites, the ability to meet diffuser performance goals, and the ability to limit geotechnical risk concerns. Environmental studies and diffuser design analyses presented in this Technical Memorandum indicate that all potential diffuser sites would be protective of human and environmental health and would meet all diffuser performance goals.

Although locating the diffuser further from the shoreline would increase construction costs without significantly increasing diffuser performance, geotechnical risk concerns and the potential for submarine slides suggest that the diffuser should be located away from the toe of the slope to reduce diffuser burial risks. It is recommended that diffusers in both alternative outfall Zones 6 and 7S be located at least 500 feet, and preferably 1,000 feet, from the toe of the slope due to the presence of relatively steep slopes and based on the preliminary geotechnical data.

6.1.1. Outfall Zone 6

Potential diffuser sites with little, if any, slope are located beyond 5,000 feet offshore at water depths of approximately –600 feet MLLW (see Figure 4). Recommended starting locations for the diffuser segment along the potential outfall alignment in Zone 6 is as shown in Figure 10.

6.1.2. Outfall Zone 7S

Potential diffuser areas with little, if any, slope are located beyond 4,500 feet from the tip of Point Wells (5,500 feet from the main shoreline). These diffuser locations are at water depths of approximately –600 feet MLLW (see Figures 5 through 7). Recommended starting locations for the diffuser segment along each potential outfall alignment in Zone 7S are as shown in Figure 11.

6.2. Diffuser Length

The marine outfall siting studies Phase 3 summarized in this Technical Memorandum show that a diffuser length of 250 feet is protective of human and environmental health and is sufficient to meet applicable water quality standards. However, the dilution modeling indicates that a minimum diffuser length of 400 feet is required to maintain a trapping depth of –70 feet MLLW at maximum month wet weather flow and a diffuser depth of –600 feet MLLW. The results of the environmental studies show that the greatest increase in diffuser performance typically occurs between 250 and 500 feet.

Hydraulic analyses of port flow distribution show that variation in port velocity is reduced as the diffuser segment length is decreased. Increasing the diffuser segment length and using a stepped diffuser port diameter, as discussed in Section 5.7.3, would minimize variation in port velocity and improve hydraulic performance.

Based on the trapping depth results, the desire for improved dilution and hydraulic performance, and the presence of favorable diffuser locations, a diffuser length of 500 feet is recommended. Increasing the diffuser length beyond 500 feet would not significantly improve diffuser performance.

6.3. Materials, Size, and Construction Method

Based on estimated Brightwater System flows and the outfall pipeline hydraulic analysis presented in the Brightwater Marine Outfall Conceptual Design Report (King County, 2002b), a single 60-inch diffuser pipe segment would be selected to match the anticipated outfall pipeline diameter (66 inches for subalternative with Edmonds and Lynnwood flows). Updated hydraulic modeling of the entire outfall pipeline will be performed as part of continuing predesign efforts, but are not within the scope of this Technical Memorandum.

As discussed in Section 5.8, the diffuser is likely to be installed in conjunction with the offshore outfall segment. Materials utilized in construction of the diffuser segment (excluding potential diffuser port riser materials) are likely to match those of the offshore outfall segment. Selection of the offshore and diffuser segment materials and construction methods will be discussed in a separate Technical Memorandum.

6.4. Port Configuration

The environmental studies discussed in this report show that diffuser port configuration has only a minor impact on far-field dilution and transport of the discharged effluent. The hydraulic performance of the assumed port configuration, based on King County's South Treatment Plant outfall, meets diffuser design criteria within the anticipated Brightwater System flow range.

Additional diffuser modeling studies of specific port configurations using the diffuser lengths and locations recommended herein is required to evaluate diffuser performance and the ability to meet diffuser criteria. Diffuser port configuration and final diffuser design will be part of the Brightwater Predesign Report to be completed after issuance of the Final EIS.

6.5. Diffuser Design Details

Diffuser design details, such as risers, check valves, blind ports, and a self-cleaning end port would be selected based, in part, on existing outfall and diffuser maintenance reports completed for King County's South Treatment Plant outfall and other marine outfalls. Recommended diffuser design details should minimize maintenance efforts required over the life of the outfall.

Selection of diffuser design details is evaluated in Section 5.9. Based on this preliminary evaluation, it is recommended that blind ports should not be utilized due to the difficulty in accessing the diffuser ports at depth. Check valves would be a more favorable method for preventing seawater intrusion at low flows, but may not be necessary based on hydraulic analyses presented in Section 5.7. Risers are not anticipated to be required since diffuser locations with little or no slope are available in both outfall Zones 6 and 7S. The natural sedimentation of material on the seafloor or settlement of material below the diffuser is unlikely to necessitate use of risers to prevent burial over the design life of the outfall. It is anticipated that a self-cleaning end port would be utilized in the design of the Brightwater Marine Outfall diffuser. Detailed design of the end port would be completed during final design.

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Figures

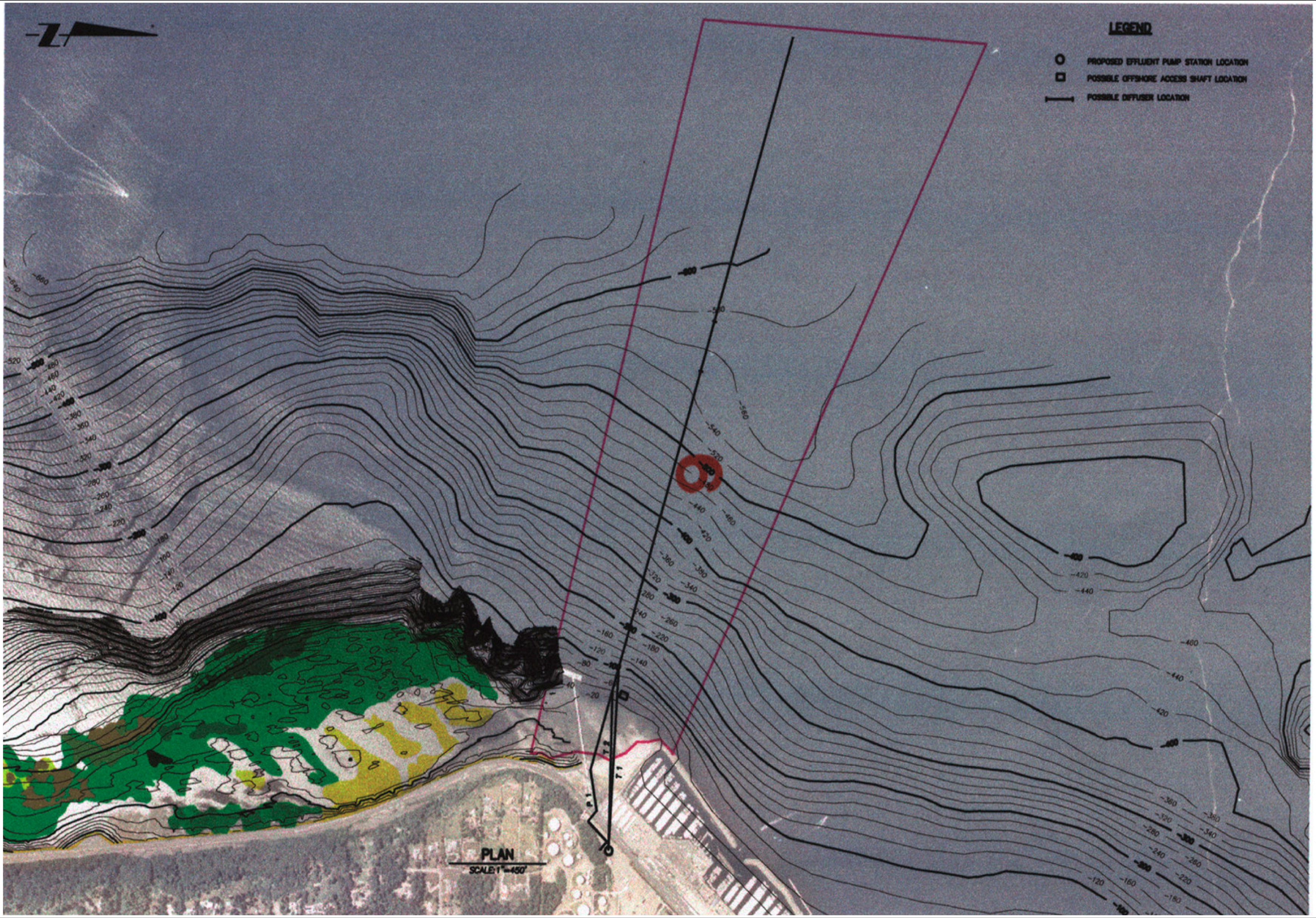

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Figure 1
Conceptual Outfall Alignments - (UNOCAL) - Zone 6
BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM

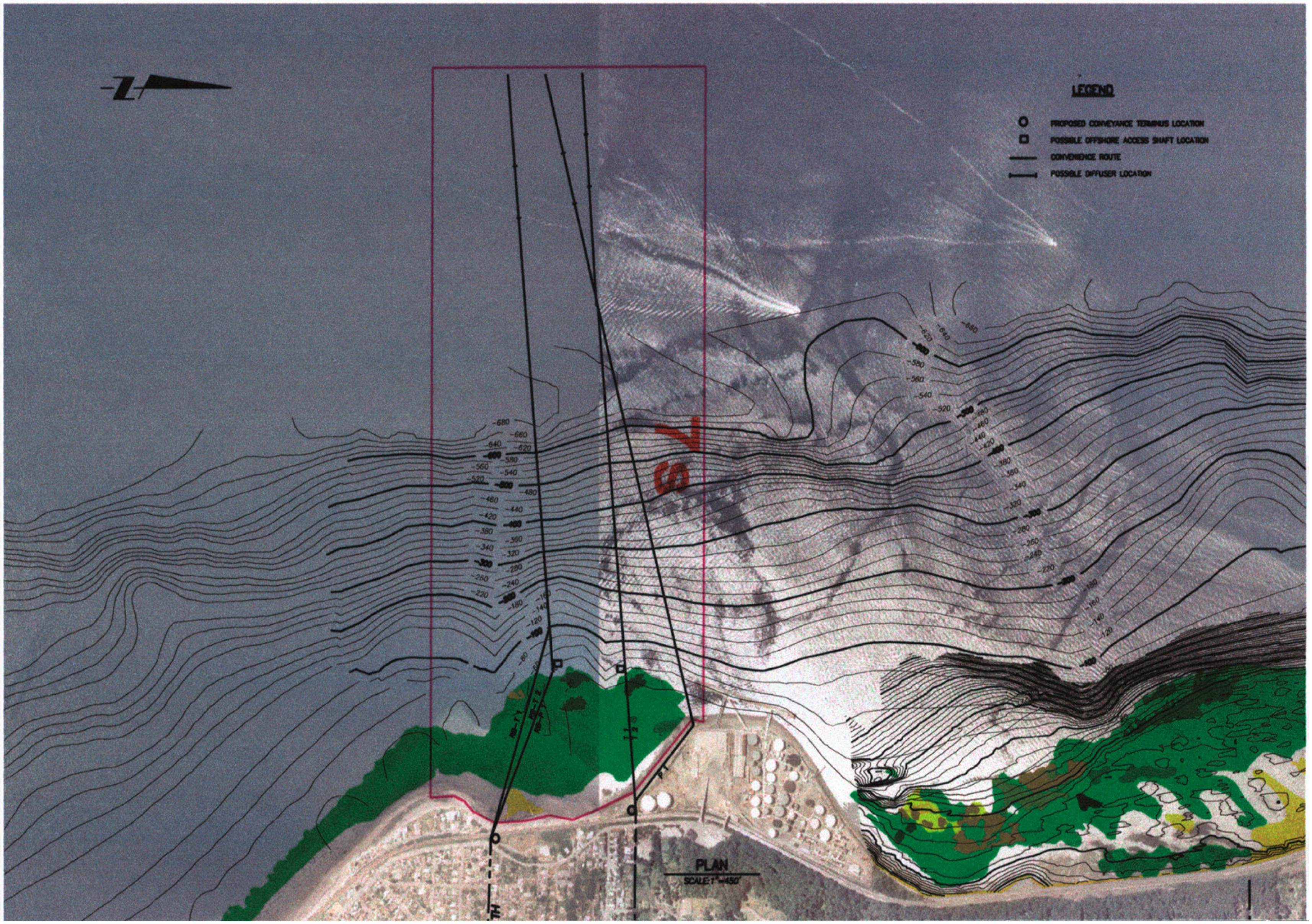

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Figure 2

Conceptual Outfall Alignments - (Route 9) - Zone 7S

BRIGHTWATER REGIONAL
WASTEWATER TREATMENT SYSTEM

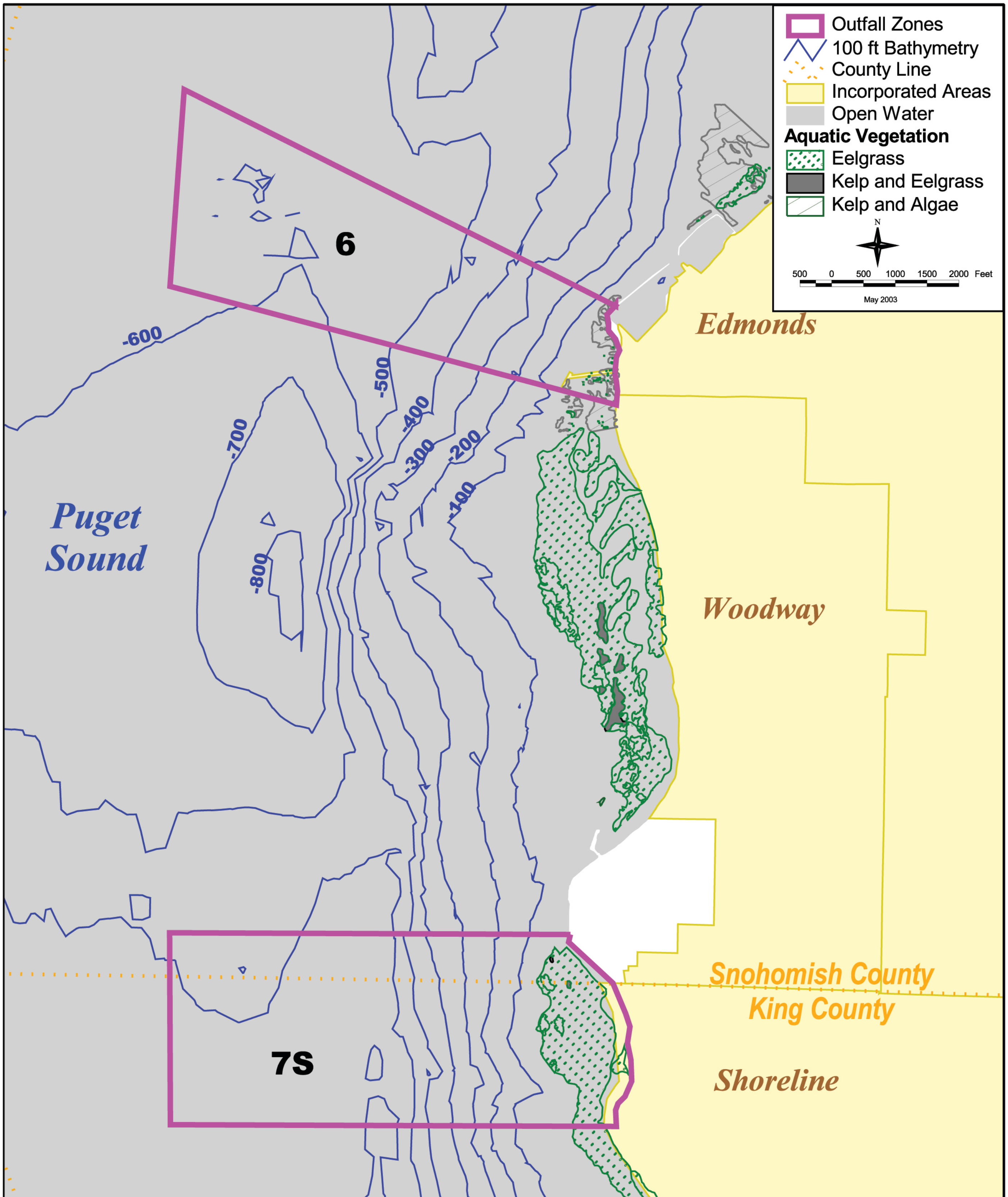

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Figure 3
Marine Outfall Zones
BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM

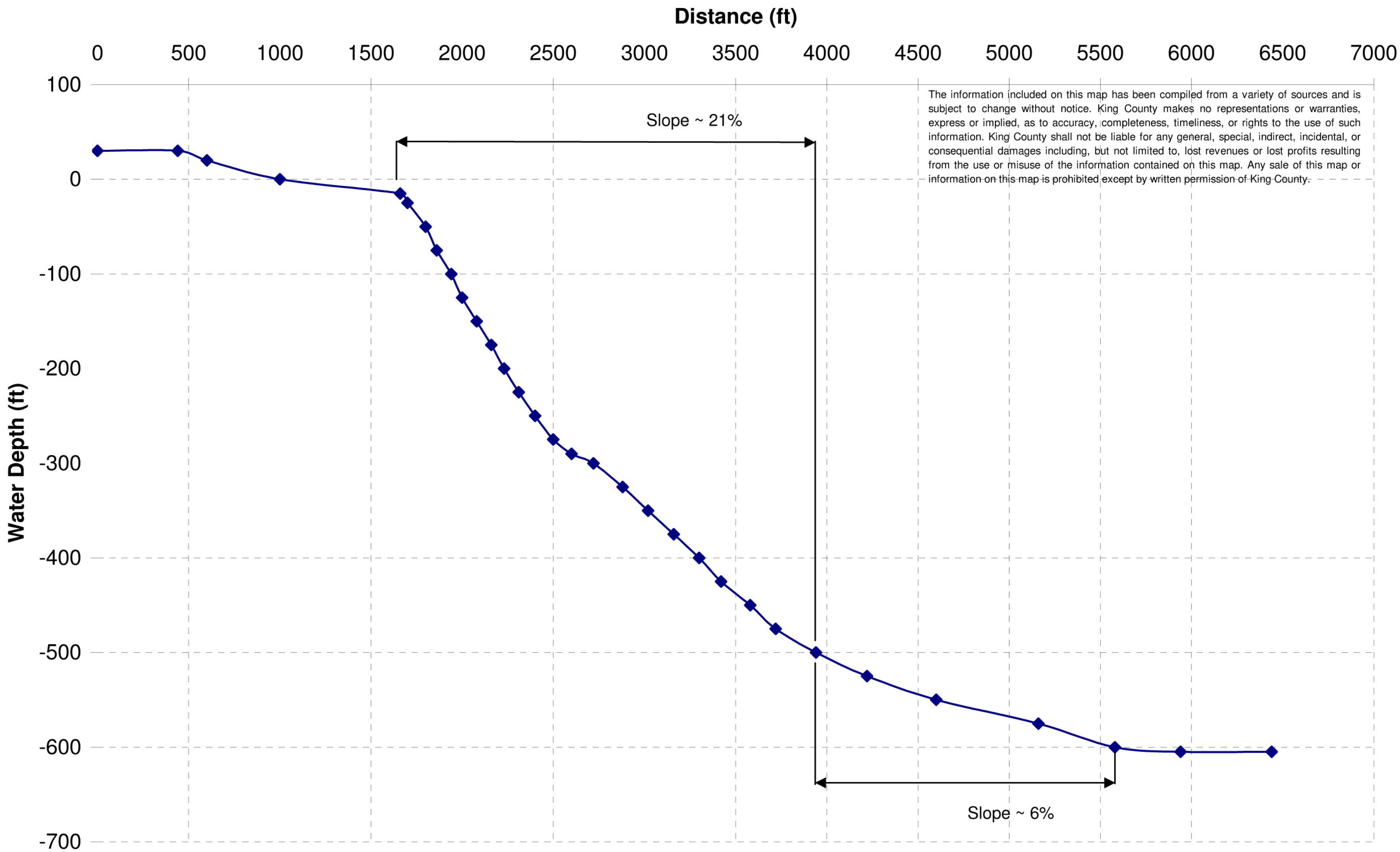

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Figure 4
UNOCAL Plant Site Alignment Profile
BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM

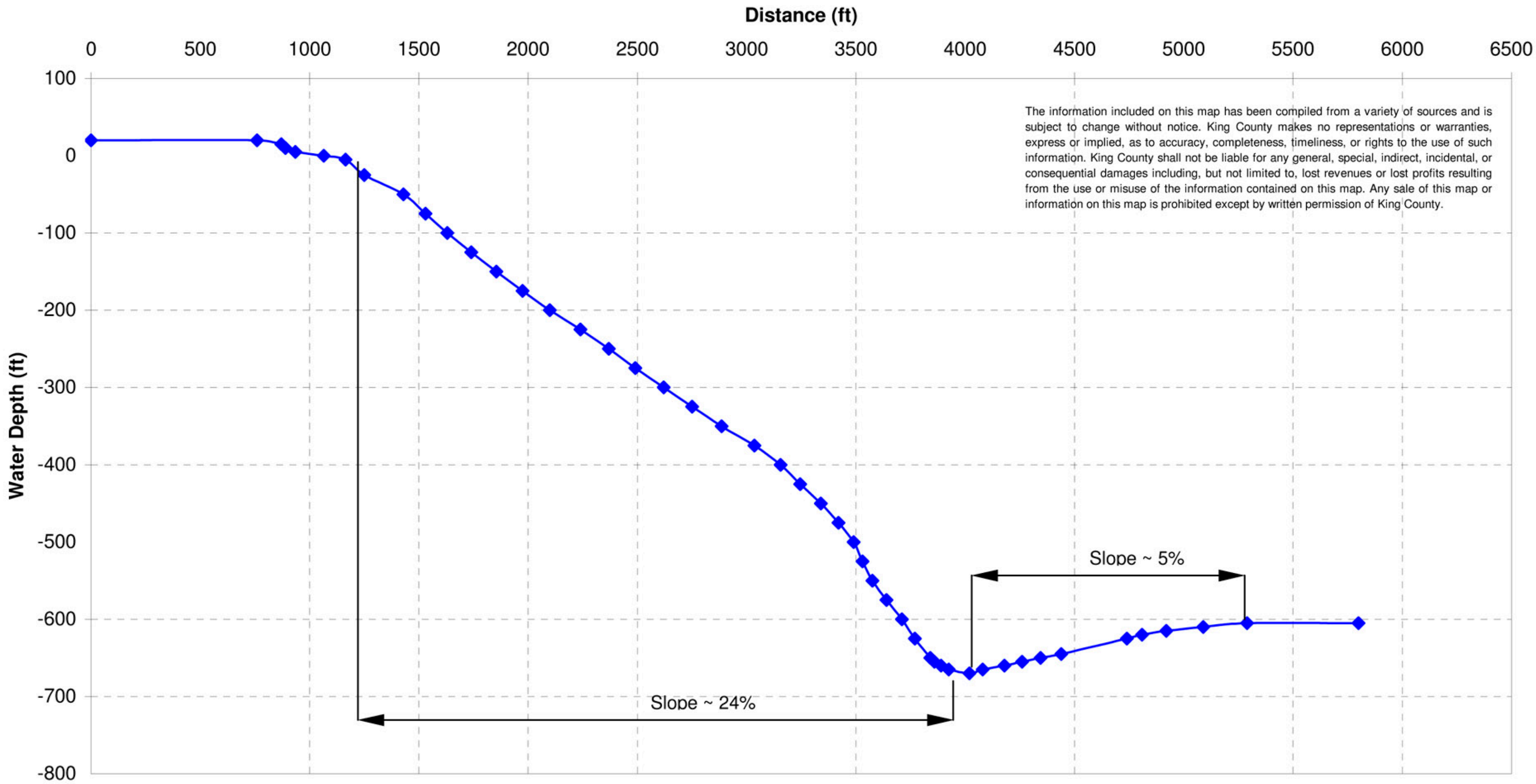

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Figure 5
Lower Point Wells Alignment Profile
BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM

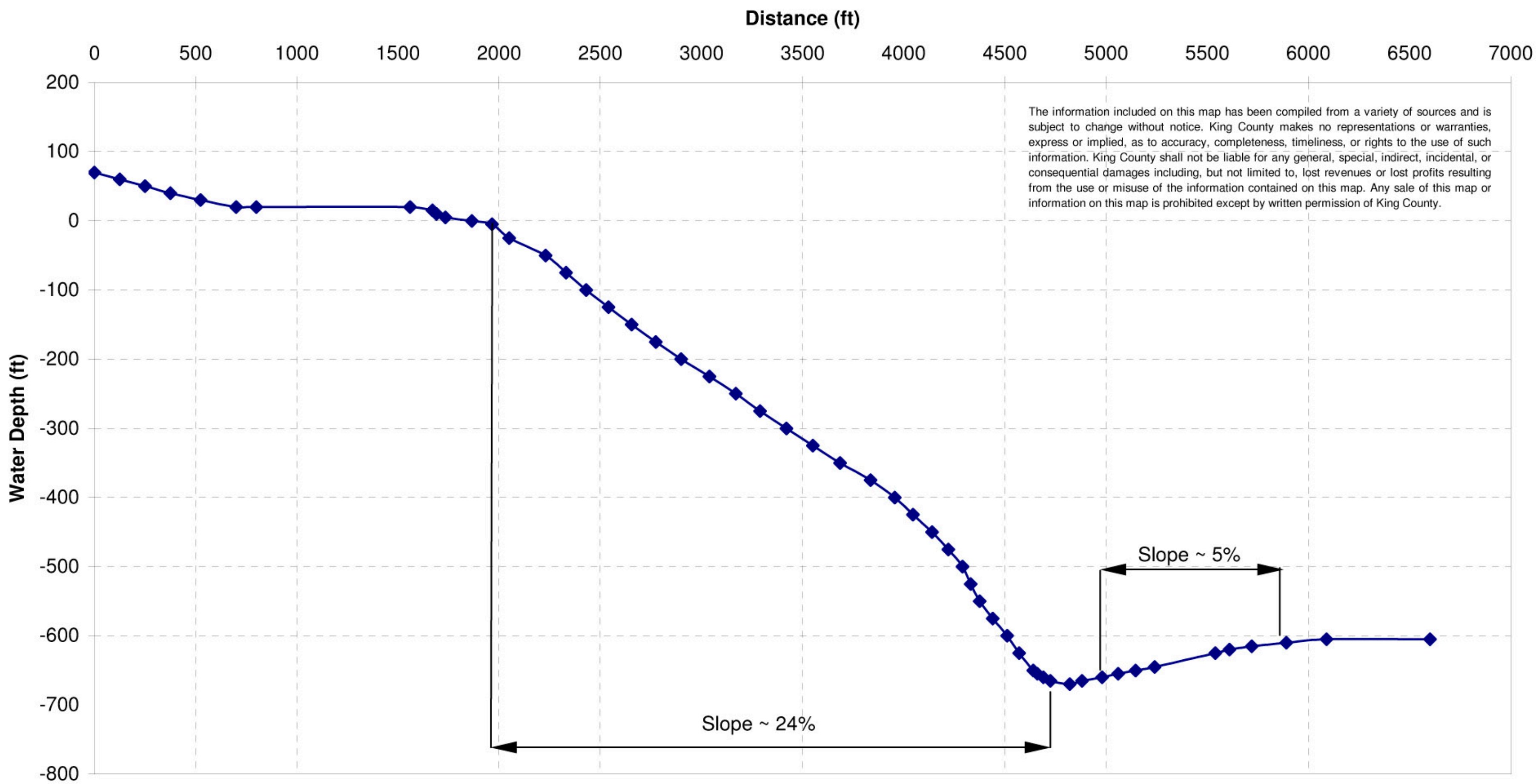

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Figure 6
Upper Point Wells Alignment Profile
BRIGHTWATER REGIONAL
WASTEWATER TREATMENT SYSTEM

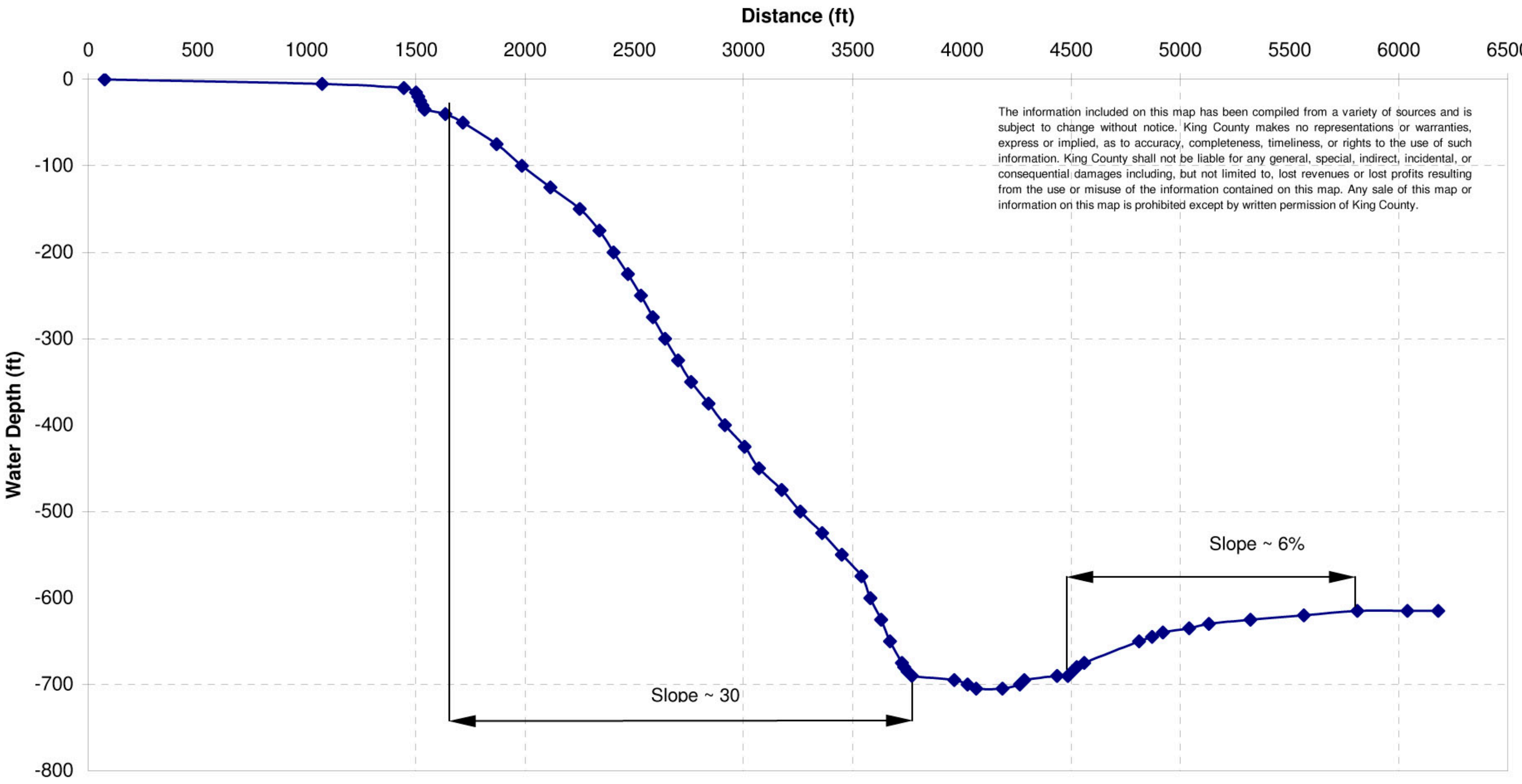

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Figure 7

Richmond Beach Alignment Profile

BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM

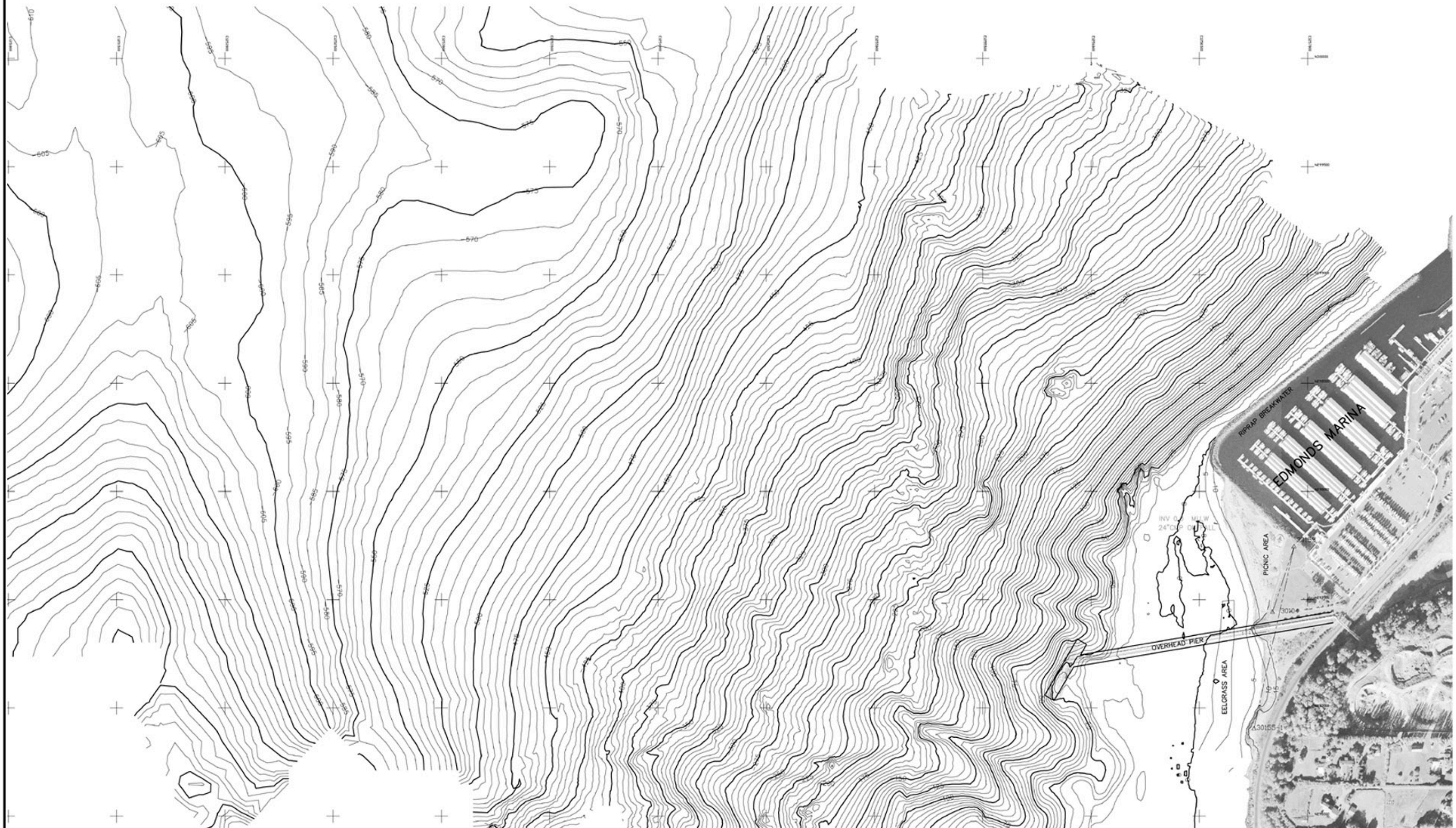

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Figure 8
Zone 6 Bathymetry
BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM

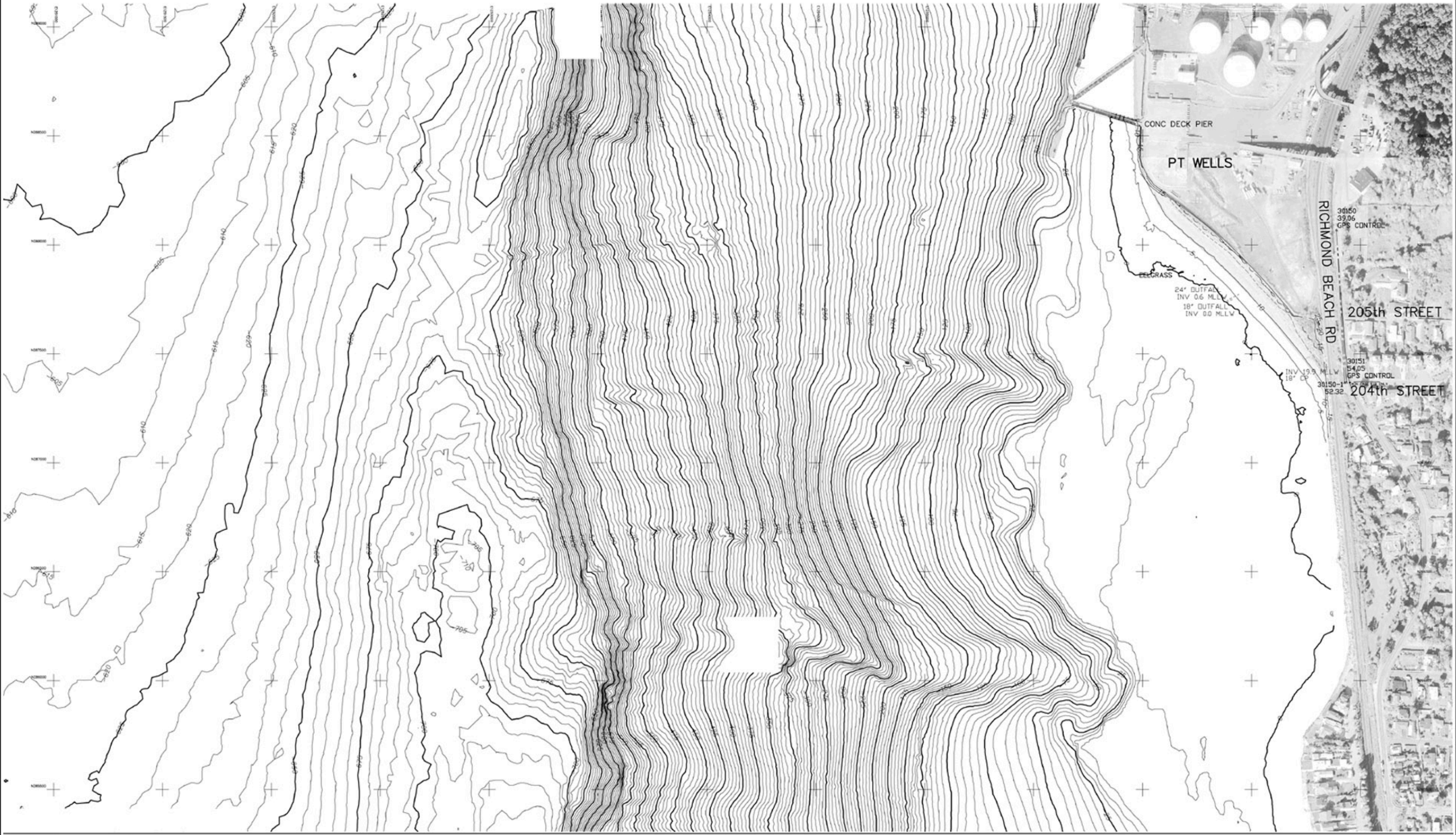

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Figure 9
Zone 7S Bathymetry
BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM

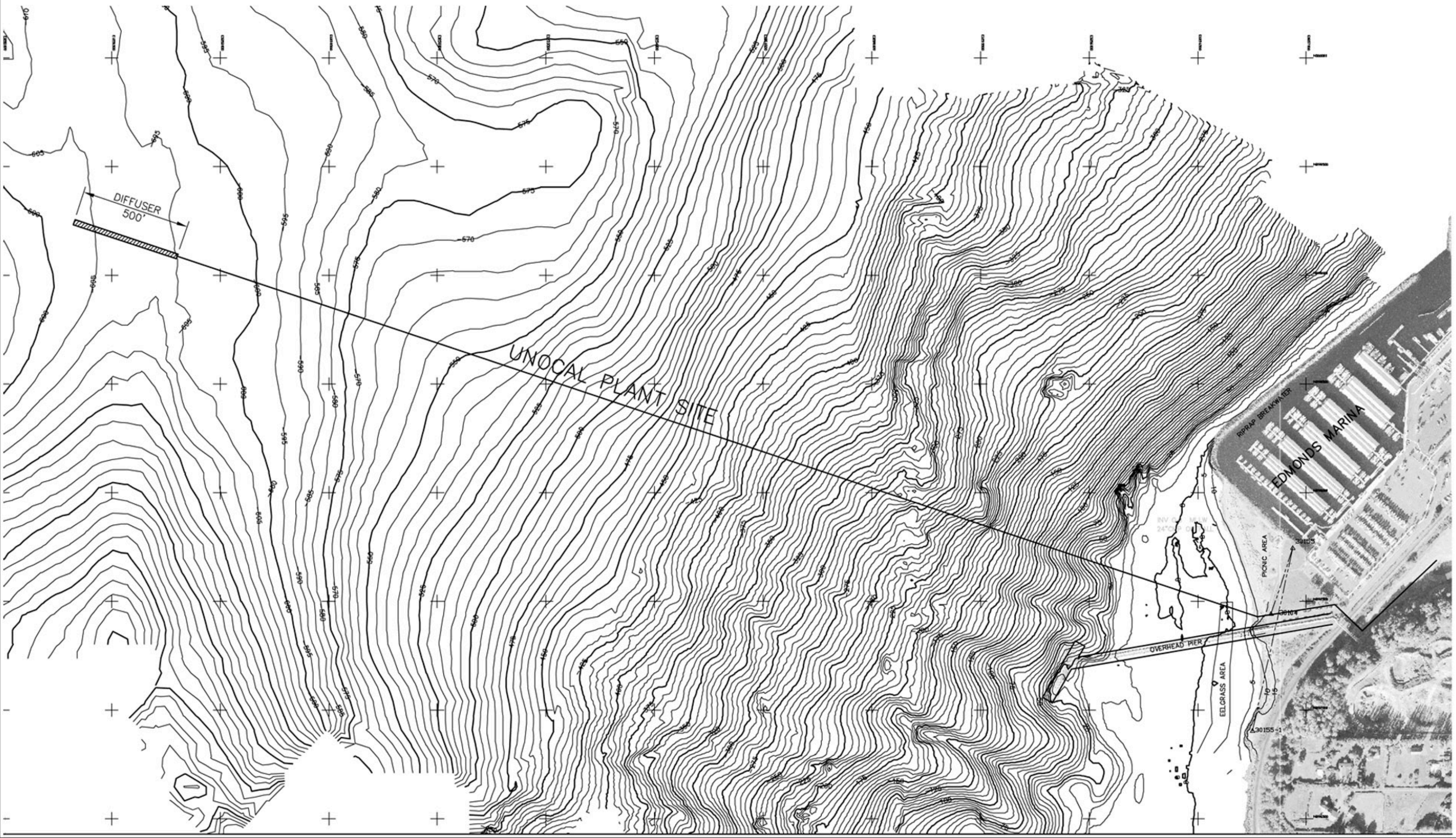

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Figure 10

Zone 6 Bathymetry, Alignment, and Diffuser Location

BRIGHTWATER REGIONAL
WASTEWATER TREATMENT SYSTEM

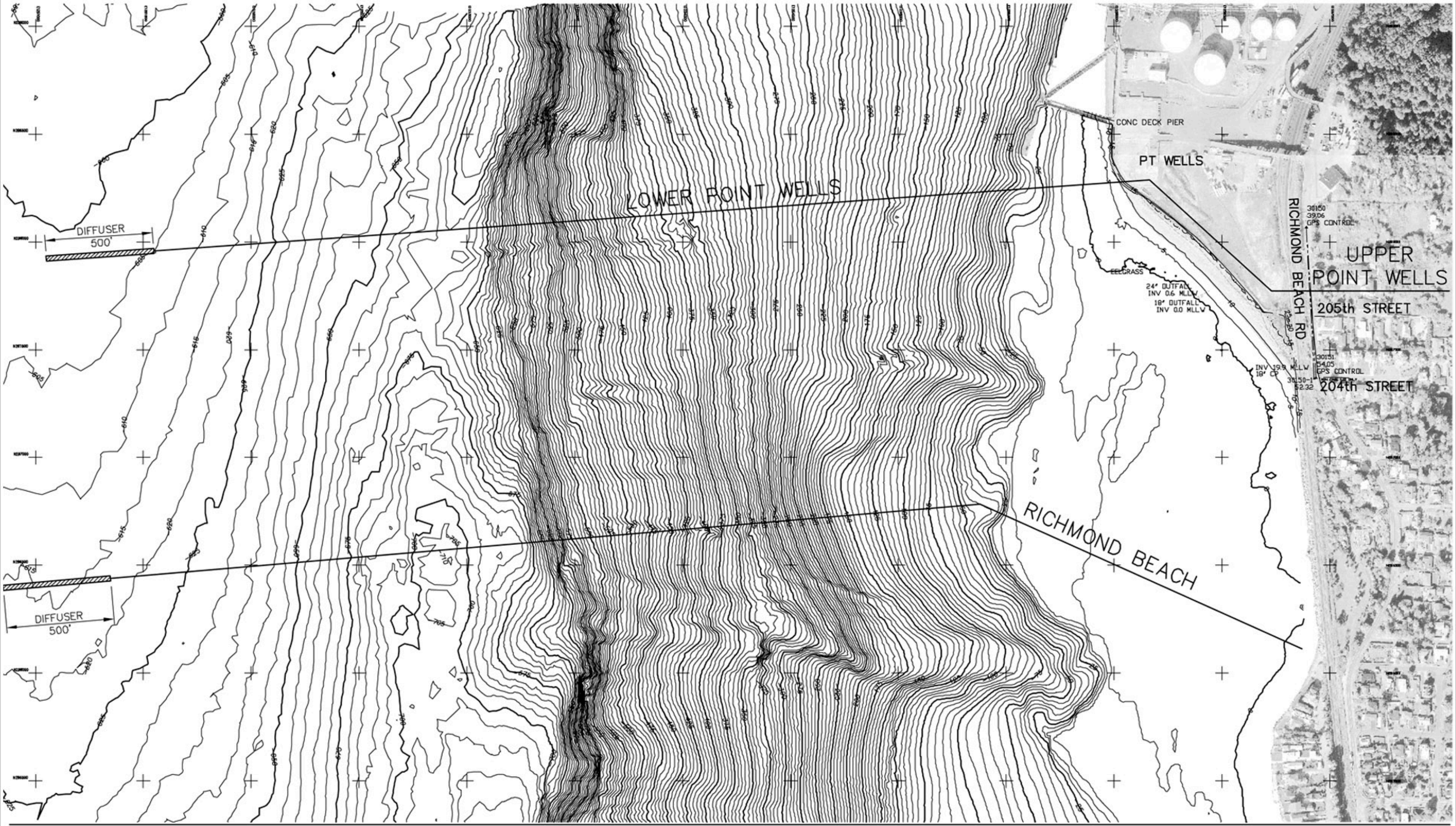

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Figure 11

Zone 7S Bathymetry, Alignment, and Diffuser Location

BRIGHTWATER REGIONAL
WASTEWATER TREATMENT SYSTEM

Final

Appendix A
Diffuser Predesign ─
Hydraulic Model Spreadsheet

PMX

Diffuser Design Parameters:			Port Design Parameters:		
MGD	129.0	mgd			
Enter Design Flow:	199.6	cfs	Enter Port Type (Riser or Orifice):	Orifice	
Enter Diffuser Length:	500	ft	Enter Entrance Loss Coefficient:	0.52	
Enter Diffuser Diameter:	5.0	ft	Enter Length of Riser:	0.0	ft
Enter Number of Ports:	168		Enter Diameter of Riser:	0.33	ft
Enter Roughness Factor:	0.000300	Steel	Enter Roughness Factor:	0.000300	Steel
Enter Effluent Specific Gravity:	0.9991	wastewater	Enter Elbow Loss Coefficient:	0.00	None
Enter Effluent Kinematic Viscosity:	1.50E-05	ft2/sec	Enter Contraction Loss Coefficient:	0.00	None
			Enter Jet Contraction Coefficient:	1.00	
Select Total Head of End Port:	4.410	ft			
Flows Matched:	199.47	cfs	YES		
Diffuser Driving Head:	5.18	ft			

Port Number	Port Diameter (in)	Port Spacing (ft)	Port Depth STP Datum (ft)	Diffuser Diameter (ft)	Diffuser Slope (ft/ft)	Ambient Spec. Grav. at Port Ht.	(pa - po)/po	Distance to Upstream Port (ft)	Port Diameter (ft)	Port Area (ft2)	Cumulative Port Area (ft2)	Diffuser Area (ft2)	Cumulative Port/Diff. Area (%)	Ratio of Port to Diff. Diameter	Port Discharge (cfs)	Port Velocity (ft/sec)	Riser Moody Friction Factor	Port X Factor
1	*5.000*	*3.00*	610.00	*5.00*	*0.0000*	*1.0235*	0.02442	*0.00*	0.4167	0.1364	0.1364	19.635	0.69%	0.08333	1.5236	11.17	0.0201	2.275
2	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	3.00	0.4167	0.1364	0.2727	19.635	1.39%	0.08333	1.5235	11.17	0.0201	2.275
3	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	6.00	0.4167	0.1364	0.4091	19.635	2.08%	0.08333	1.5234	11.17	0.0201	2.275
4	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	9.00	0.4167	0.1364	0.5454	19.635	2.78%	0.08333	1.5232	11.17	0.0201	2.275
5	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	12.00	0.4167	0.1364	0.6818	19.635	3.47%	0.08333	1.5229	11.17	0.0201	2.276
6	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	15.00	0.4167	0.1364	0.8181	19.635	4.17%	0.08333	1.5226	11.17	0.0201	2.276
7	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	18.00	0.4167	0.1364	0.9545	19.635	4.86%	0.08333	1.5222	11.16	0.0201	2.277
8	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	21.00	0.4167	0.1364	1.0908	19.635	5.56%	0.08333	1.5217	11.16	0.0201	2.278
9	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	24.00	0.4167	0.1364	1.2272	19.635	6.25%	0.08333	1.5212	11.16	0.0201	2.279
10	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	27.00	0.4167	0.1364	1.3635	19.635	6.94%	0.08333	1.5207	11.15	0.0201	2.279
11	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	30.00	0.4167	0.1364	1.4999	19.635	7.64%	0.08333	1.5200	11.15	0.0201	2.280
12	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	33.00	0.4167	0.1364	1.6362	19.635	8.33%	0.08333	1.5193	11.14	0.0201	2.282
13	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	36.00	0.4167	0.1364	1.7726	19.635	9.03%	0.08333	1.5185	11.14	0.0201	2.283
14	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	39.00	0.4167	0.1364	1.9090	19.635	9.72%	0.08333	1.5177	11.13	0.0201	2.284
15	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	42.00	0.4167	0.1364	2.0453	19.635	10.42%	0.08333	1.5168	11.12	0.0201	2.286
16	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	45.00	0.4167	0.1364	2.1817	19.635	11.11%	0.08333	1.5159	11.12	0.0201	2.287
17	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	48.00	0.4167	0.1364	2.3180	19.635	11.81%	0.08333	1.5149	11.11	0.0201	2.289
18	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	51.00	0.4167	0.1364	2.4544	19.635	12.50%	0.08333	1.5138	11.10	0.0201	2.290
19	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	54.00	0.4167	0.1364	2.5907	19.635	13.19%	0.08333	1.5127	11.09	0.0201	2.292
20	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	57.00	0.4167	0.1364	2.7271	19.635	13.89%	0.08333	1.5115	11.09	0.0201	2.294
21	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	60.00	0.4167	0.1364	2.8634	19.635	14.58%	0.08333	1.5103	11.08	0.0201	2.296
22	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	63.00	0.4167	0.1364	2.9998	19.635	15.28%	0.08333	1.5090	11.07	0.0201	2.298
23	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	66.00	0.4167	0.1364	3.1361	19.635	15.97%	0.08333	1.5076	11.06	0.0201	2.300
24	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	69.00	0.4167	0.1364	3.2725	19.635	16.67%	0.08333	1.5062	11.05	0.0201	2.303
25	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	72.00	0.4167	0.1364	3.4088	19.635	17.36%	0.08333	1.5047	11.04	0.0201	2.305
26	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	75.00	0.4167	0.1364	3.5452	19.635	18.06%	0.08333	1.5032	11.02	0.0201	2.308
27	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	78.00	0.4167	0.1364	3.6816	19.635	18.75%	0.08333	1.5016	11.01	0.0201	2.310
28	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	81.00	0.4167	0.1364	3.8179	19.635	19.44%	0.08333	1.4999	11.00	0.0201	2.313
29	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	84.00	0.4167	0.1364	3.9543	19.635	20.14%	0.08333	1.4982	10.99	0.0201	2.316
30	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	87.00	0.4167	0.1364	4.0906	19.635	20.83%	0.08333	1.4964	10.97	0.0201	2.319
31	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	90.00	0.4167	0.1364	4.2270	19.635	21.53%	0.08333	1.4946	10.96	0.0201	2.322
32	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	93.00	0.4167	0.1364	4.3633	19.635	22.22%	0.08333	1.4927	10.95	0.0201	2.325
33	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	96.00	0.4167	0.1364	4.4997	19.635	22.92%	0.08333	1.4908	10.93	0.0201	2.329
34	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	99.00	0.4167	0.1364	4.6360	19.635	23.61%	0.08333	1.4888	10.92	0.0201	2.332
35	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	102.00	0.4167	0.1364	4.7724	19.635	24.31%	0.08333	1.4868	10.90	0.0201	2.336
36	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	105.00	0.4167	0.1364	4.9087	19.635	25.00%	0.08333	1.4847	10.89	0.0201	2.339
37	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	108.00	0.4167	0.1364	5.0451	19.635	25.69%	0.08333	1.4825	10.87	0.0201	2.343
38	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	111.00	0.4167	0.1364	5.1814	19.635	26.39%	0.08333	1.4803	10.86	0.0201	2.347

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Diffuser Design Parameters:			Port Design Parameters:		
MGD	129.0	mgd			
Enter Design Flow:	199.6	cfs	Enter Port Type (Riser or Orifice):	Orifice	
Enter Diffuser Length:	500	ft	Enter Entrance Loss Coefficient:	0.52	
Enter Diffuser Diameter:	5.0	ft	Enter Length of Riser:	0.0	ft
Enter Number of Ports:	168		Enter Diameter of Riser:	0.33	ft
Enter Roughness Factor:	0.000300	Steel	Enter Roughness Factor:	0.000300	Steel
Enter Effluent Specific Gravity:	0.9991	wastewater	Enter Elbow Loss Coefficient:	0.00	None
Enter Effluent Kinematic Viscosity:	1.50E-05	ft2/sec	Enter Contraction Loss Coefficient:	0.00	None
			Enter Jet Contraction Coefficient:	1.00	
Select Total Head of End Port:	4.410	ft			
Flows Matched:	199.47	cfs	**YES**		
Diffuser Driving Head:	5.18	ft			

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Port Number	Port Diameter (in)	Port Spacing (ft)	Port Depth STP Datum (ft)	Diffuser Diameter (ft)	Diffuser Slope (ft/ft)	Ambient Spec. Grav. at Port Ht.	(pa - po)/po	Distance to Upstream Port (ft)	Port Diameter (ft)	Port Area (ft2)	Cumulative Port Area (ft2)	Diffuser Area (ft2)	Cumulative Port/Diff. Area (%)	Ratio of Port to Diff. Diameter	Port Discharge (cfs)	Port Velocity (ft/sec)	Riser Moody Friction Factor	Port X Factor
39	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	114.00	0.4167	0.1364	5.3178	19.635	27.08%	0.08333	1.4781	10.84	0.0201	2.351
40	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	117.00	0.4167	0.1364	5.4542	19.635	27.78%	0.08333	1.4758	10.82	0.0201	2.355
41	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	120.00	0.4167	0.1364	5.5905	19.635	28.47%	0.08333	1.4734	10.81	0.0201	2.359
42	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	123.00	0.4167	0.1364	5.7269	19.635	29.17%	0.08333	1.4710	10.79	0.0201	2.364
43	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	126.00	0.4167	0.1364	5.8632	19.635	29.86%	0.08333	1.4685	10.77	0.0201	2.368
44	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	129.00	0.4167	0.1364	5.9996	19.635	30.56%	0.08333	1.4660	10.75	0.0201	2.373
45	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	132.00	0.4167	0.1364	6.1359	19.635	31.25%	0.08333	1.4634	10.73	0.0201	2.378
46	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	135.00	0.4167	0.1364	6.2723	19.635	31.94%	0.08333	1.4608	10.71	0.0201	2.382
47	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	138.00	0.4167	0.1364	6.4086	19.635	32.64%	0.08333	1.4581	10.69	0.0201	2.387
48	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	141.00	0.4167	0.1364	6.5450	19.635	33.33%	0.08333	1.4554	10.67	0.0201	2.393
49	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	144.00	0.4167	0.1364	6.6813	19.635	34.03%	0.08333	1.4526	10.65	0.0201	2.398
50	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	147.00	0.4167	0.1364	6.8177	19.635	34.72%	0.08333	1.4498	10.63	0.0201	2.403
51	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	150.00	0.4167	0.1364	6.9540	19.635	35.42%	0.08333	1.4469	10.61	0.0201	2.409
52	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	153.00	0.4167	0.1364	7.0904	19.635	36.11%	0.08333	1.4440	10.59	0.0201	2.415
53	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	156.00	0.4167	0.1364	7.2268	19.635	36.81%	0.08333	1.4410	10.57	0.0201	2.420
54	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	159.00	0.4167	0.1364	7.3631	19.635	37.50%	0.08333	1.4380	10.55	0.0201	2.426
55	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	162.00	0.4167	0.1364	7.4995	19.635	38.19%	0.08333	1.4349	10.52	0.0201	2.433
56	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	165.00	0.4167	0.1364	7.6358	19.635	38.89%	0.08333	1.4318	10.50	0.0201	2.439
57	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	168.00	0.4167	0.1364	7.7722	19.635	39.58%	0.08333	1.4286	10.48	0.0201	2.445
58	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	171.00	0.4167	0.1364	7.9085	19.635	40.28%	0.08333	1.4254	10.45	0.0201	2.452
59	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	174.00	0.4167	0.1364	8.0449	19.635	40.97%	0.08333	1.4222	10.43	0.0202	2.458
60	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	177.00	0.4167	0.1364	8.1812	19.635	41.67%	0.08333	1.4189	10.41	0.0202	2.465
61	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	180.00	0.4167	0.1364	8.3176	19.635	42.36%	0.08333	1.4155	10.38	0.0202	2.472
62	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	183.00	0.4167	0.1364	8.4539	19.635	43.06%	0.08333	1.4121	10.36	0.0202	2.480
63	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	186.00	0.4167	0.1364	8.5903	19.635	43.75%	0.08333	1.4087	10.33	0.0202	2.487
64	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	189.00	0.4167	0.1364	8.7266	19.635	44.44%	0.08333	1.4052	10.31	0.0202	2.494
65	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	192.00	0.4167	0.1364	8.8630	19.635	45.14%	0.08333	1.4017	10.28	0.0202	2.502
66	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	195.00	0.4167	0.1364	8.9994	19.635	45.83%	0.08333	1.3981	10.25	0.0202	2.510
67	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	198.00	0.4167	0.1364	9.1357	19.635	46.53%	0.08333	1.3945	10.23	0.0202	2.518
68	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	201.00	0.4167	0.1364	9.2721	19.635	47.22%	0.08333	1.3908	10.20	0.0202	2.526
69	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	204.00	0.4167	0.1364	9.4084	19.635	47.92%	0.08333	1.3871	10.17	0.0202	2.535
70	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	207.00	0.4167	0.1364	9.5448	19.635	48.61%	0.08333	1.3834	10.15	0.0202	2.543
71	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	210.00	0.4167	0.1364	9.6811	19.635	49.31%	0.08333	1.3796	10.12	0.0202	2.552
72	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	213.00	0.4167	0.1364	9.8175	19.635	50.00%	0.08333	1.3758	10.09	0.0202	2.561
73	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	216.00	0.4167	0.1364	9.9538	19.635	50.69%	0.08333	1.3719	10.06	0.0202	2.570
74	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	219.00	0.4167	0.1364	10.0902	19.635	51.39%	0.08333	1.3680	10.03	0.0202	2.579
75	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	222.00	0.4167	0.1364	10.2265	19.635	52.08%	0.08333	1.3640	10.00	0.0202	2.589
76	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	225.00	0.4167	0.1364	10.3629	19.635	52.78%	0.08333	1.3601	9.97	0.0202	2.598

PMX PMX

Diffuser Design Parameters:			**Port Design Parameters:**		
MGD	129.0	mgd			
Enter Design Flow:	199.6	cfs	Enter Port Type (Riser or Orifice):	Orifice	
Enter Diffuser Length:	500	ft	Enter Entrance Loss Coefficient:	0.52	
Enter Diffuser Diameter:	5.0	ft	Enter Length of Riser:	0.0	ft
Enter Number of Ports:	168		Enter Diameter of Riser:	0.33	ft
Enter Roughness Factor:	0.000300	Steel	Enter Roughness Factor:	0.000300	Steel
Enter Effluent Specific Gravity:	0.9991	wastewater	Enter Elbow Loss Coefficient:	0.00	None
Enter Effluent Kinematic Viscosity:	1.50E-05	ft2/sec	Enter Contraction Loss Coefficient:	0.00	None
			Enter Jet Contraction Coefficient:	1.00	
Select Total Head of End Port:	4.410	ft			
Flows Matched:	199.47	cfs	**YES**		
Diffuser Driving Head:	5.18	ft			

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Port Number	Port Diameter (in)	Port Spacing (ft)	Port Depth STP Datum (ft)	Diffuser Diameter (ft)	Diffuser Slope (ft/ft)	Ambient Spec. Grav. at Port Ht.	(pa - po)/po	Distance to Upstream Port (ft)	Port Diameter (ft)	Port Area (ft2)	Cumulative Port Area (ft2)	Diffuser Area (ft2)	Cumulative Port/Diff. Area (%)	Ratio of Port to Diff. Diameter	Port Discharge (cfs)	Port Velocity (ft/sec)	Riser Moody Friction Factor	Port X Factor
77	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	228.00	0.4167	0.1364	10.4992	19.635	53.47%	0.08333	1.3560	9.94	0.0202	2.608
78	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	231.00	0.4167	0.1364	10.6356	19.635	54.17%	0.08333	1.3520	9.92	0.0202	2.618
79	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	234.00	0.4167	0.1364	10.7720	19.635	54.86%	0.08333	1.3479	9.89	0.0202	2.629
80	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	237.00	0.4167	0.1364	10.9083	19.635	55.56%	0.08333	1.3437	9.85	0.0202	2.639
81	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	240.00	0.4167	0.1364	11.0447	19.635	56.25%	0.08333	1.3396	9.82	0.0202	2.650
82	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	243.00	0.4167	0.1364	11.1810	19.635	56.94%	0.08333	1.3353	9.79	0.0202	2.661
83	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	246.00	0.4167	0.1364	11.3174	19.635	57.64%	0.08333	1.3311	9.76	0.0202	2.672
84	5.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	249.00	0.4167	0.1364	11.4537	19.635	58.33%	0.08333	1.3268	9.73	0.0202	2.684
85	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	252.00	0.3333	0.0873	11.5410	19.635	58.78%	0.06667	1.0351	11.86	0.0205	1.802
86	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	255.00	0.3333	0.0873	11.6283	19.635	59.22%	0.06667	1.0326	11.83	0.0205	1.808
87	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	258.00	0.3333	0.0873	11.7155	19.635	59.67%	0.06667	1.0301	11.80	0.0205	1.814
88	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	261.00	0.3333	0.0873	11.8028	19.635	60.11%	0.06667	1.0276	11.78	0.0205	1.821
89	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	264.00	0.3333	0.0873	11.8901	19.635	60.56%	0.06667	1.0250	11.75	0.0205	1.827
90	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	267.00	0.3333	0.0873	11.9773	19.635	61.00%	0.06667	1.0224	11.72	0.0205	1.833
91	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	270.00	0.3333	0.0873	12.0646	19.635	61.44%	0.06667	1.0199	11.69	0.0205	1.840
92	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	273.00	0.3333	0.0873	12.1519	19.635	61.89%	0.06667	1.0173	11.66	0.0205	1.847
93	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	276.00	0.3333	0.0873	12.2391	19.635	62.33%	0.06667	1.0147	11.63	0.0205	1.853
94	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	279.00	0.3333	0.0873	12.3264	19.635	62.78%	0.06667	1.0121	11.60	0.0205	1.860
95	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	282.00	0.3333	0.0873	12.4137	19.635	63.22%	0.06667	1.0094	11.57	0.0205	1.867
96	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	285.00	0.3333	0.0873	12.5009	19.635	63.67%	0.06667	1.0068	11.54	0.0205	1.874
97	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	288.00	0.3333	0.0873	12.5882	19.635	64.11%	0.06667	1.0041	11.51	0.0205	1.881
98	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	291.00	0.3333	0.0873	12.6755	19.635	64.56%	0.06667	1.0015	11.48	0.0205	1.889
99	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	294.00	0.3333	0.0873	12.7627	19.635	65.00%	0.06667	0.9988	11.45	0.0205	1.896
100	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	297.00	0.3333	0.0873	12.8500	19.635	65.44%	0.06667	0.9961	11.41	0.0205	1.904
101	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	300.00	0.3333	0.0873	12.9373	19.635	65.89%	0.06667	0.9934	11.38	0.0205	1.911
102	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	303.00	0.3333	0.0873	13.0245	19.635	66.33%	0.06667	0.9907	11.35	0.0205	1.919
103	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	306.00	0.3333	0.0873	13.1118	19.635	66.78%	0.06667	0.9880	11.32	0.0205	1.927
104	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	309.00	0.3333	0.0873	13.1991	19.635	67.22%	0.06667	0.9852	11.29	0.0205	1.935
105	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	312.00	0.3333	0.0873	13.2863	19.635	67.67%	0.06667	0.9825	11.26	0.0205	1.943
106	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	315.00	0.3333	0.0873	13.3736	19.635	68.11%	0.06667	0.9797	11.23	0.0205	1.951
107	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	318.00	0.3333	0.0873	13.4609	19.635	68.56%	0.06667	0.9770	11.20	0.0205	1.959
108	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	321.00	0.3333	0.0873	13.5481	19.635	69.00%	0.06667	0.9742	11.16	0.0205	1.968
109	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	324.00	0.3333	0.0873	13.6354	19.635	69.44%	0.06667	0.9714	11.13	0.0205	1.976
110	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	327.00	0.3333	0.0873	13.7227	19.635	69.89%	0.06667	0.9687	11.10	0.0205	1.985
111	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	330.00	0.3333	0.0873	13.8099	19.635	70.33%	0.06667	0.9659	11.07	0.0205	1.993
112	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	333.00	0.3333	0.0873	13.8972	19.635	70.78%	0.06667	0.9631	11.04	0.0205	2.002
113	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	336.00	0.3333	0.0873	13.9845	19.635	71.22%	0.06667	0.9602	11.00	0.0205	2.011
114	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	339.00	0.3333	0.0873	14.0717	19.635	71.67%	0.06667	0.9574	10.97	0.0205	2.021

Brightwater Conveyance System - Diffuser Predesign

PMX

PMX

Diffuser Design Parameters:			Port Design Parameters:		
MGD	129.0	mgd			
Enter Design Flow:	199.6	cfs	Enter Port Type (Riser or Orifice):	Orifice	
Enter Diffuser Length:	500	ft	Enter Entrance Loss Coefficient:	0.52	
Enter Diffuser Diameter:	5.0	ft	Enter Length of Riser:	0.0	ft
Enter Number of Ports:	168		Enter Diameter of Riser:	0.33	ft
Enter Roughness Factor:	0.000300	Steel	Enter Roughness Factor:	0.000300	Steel
Enter Effluent Specific Gravity:	0.9991	wastewater	Enter Elbow Loss Coefficient:	0.00	None
Enter Effluent Kinematic Viscosity:	1.50E-05	ft2/sec	Enter Contraction Loss Coefficient:	0.00	None
			Enter Jet Contraction Coefficient:	1.00	
Select Total Head of End Port:	4.410	ft			
Flows Matched:	199.47	cfs	YES		
Diffuser Driving Head:	5.18	ft			

Enter Desigr
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Enter Effluer
Enter Effluer
Select Total
Flows Match
Diffuser Driv

Port Number	Port Diameter (in)	Port Spacing (ft)	Port Depth STP Datum (ft)	Diffuser Diameter (ft)	Diffuser Slope (ft/ft)	Ambient Spec. Grav. at Port Ht.	(pa - po)/po	Distance to Upstream Port (ft)	Port Diameter (ft)	Port Area (ft2)	Cumulative Port Area (ft2)	Diffuser Area (ft2)	Cumulative Port/Diff. Area (%)	Ratio of Port to Diff. Diameter	Port Discharge (cfs)	Port Velocity (ft/sec)	Riser Moody Friction Factor	Port X Factor
115	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	342.00	0.3333	0.0873	14.1590	19.635	72.11%	0.06667	0.9546	10.94	0.0205	2.030
116	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	345.00	0.3333	0.0873	14.2463	19.635	72.56%	0.06667	0.9518	10.91	0.0206	2.039
117	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	348.00	0.3333	0.0873	14.3335	19.635	73.00%	0.06667	0.9489	10.87	0.0206	2.049
118	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	351.00	0.3333	0.0873	14.4208	19.635	73.44%	0.06667	0.9461	10.84	0.0206	2.058
119	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	354.00	0.3333	0.0873	14.5080	19.635	73.89%	0.06667	0.9432	10.81	0.0206	2.068
120	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	357.00	0.3333	0.0873	14.5953	19.635	74.33%	0.06667	0.9403	10.78	0.0206	2.078
121	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	360.00	0.3333	0.0873	14.6826	19.635	74.78%	0.06667	0.9375	10.74	0.0206	2.088
122	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	363.00	0.3333	0.0873	14.7698	19.635	75.22%	0.06667	0.9346	10.71	0.0206	2.098
123	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	366.00	0.3333	0.0873	14.8571	19.635	75.67%	0.06667	0.9317	10.68	0.0206	2.109
124	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	369.00	0.3333	0.0873	14.9444	19.635	76.11%	0.06667	0.9288	10.64	0.0206	2.119
125	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	372.00	0.3333	0.0873	15.0316	19.635	76.56%	0.06667	0.9259	10.61	0.0206	2.130
126	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	375.00	0.3333	0.0873	15.1189	19.635	77.00%	0.06667	0.9230	10.58	0.0206	2.141
127	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	378.00	0.3333	0.0873	15.2062	19.635	77.44%	0.06667	0.9201	10.54	0.0206	2.152
128	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	381.00	0.3333	0.0873	15.2934	19.635	77.89%	0.06667	0.9172	10.51	0.0206	2.163
129	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	384.00	0.3333	0.0873	15.3807	19.635	78.33%	0.06667	0.9143	10.48	0.0206	2.174
130	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	387.00	0.3333	0.0873	15.4680	19.635	78.78%	0.06667	0.9113	10.44	0.0206	2.186
131	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	390.00	0.3333	0.0873	15.5552	19.635	79.22%	0.06667	0.9084	10.41	0.0206	2.197
132	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	393.00	0.3333	0.0873	15.6425	19.635	79.67%	0.06667	0.9055	10.38	0.0206	2.209
133	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	396.00	0.3333	0.0873	15.7298	19.635	80.11%	0.06667	0.9026	10.34	0.0206	2.221
134	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	399.00	0.3333	0.0873	15.8170	19.635	80.56%	0.06667	0.8996	10.31	0.0206	2.233
135	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	402.00	0.3333	0.0873	15.9043	19.635	81.00%	0.06667	0.8967	10.28	0.0206	2.245
136	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	405.00	0.3333	0.0873	15.9916	19.635	81.44%	0.06667	0.8937	10.24	0.0206	2.257
137	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	408.00	0.3333	0.0873	16.0788	19.635	81.89%	0.06667	0.8908	10.21	0.0206	2.270
138	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	411.00	0.3333	0.0873	16.1661	19.635	82.33%	0.06667	0.8878	10.17	0.0206	2.283
139	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	414.00	0.3333	0.0873	16.2534	19.635	82.78%	0.06667	0.8849	10.14	0.0206	2.295
140	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	417.00	0.3333	0.0873	16.3406	19.635	83.22%	0.06667	0.8819	10.11	0.0206	2.308
141	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	420.00	0.3333	0.0873	16.4279	19.635	83.67%	0.06667	0.8790	10.07	0.0206	2.322
142	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	423.00	0.3333	0.0873	16.5152	19.635	84.11%	0.06667	0.8760	10.04	0.0207	2.335
143	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	426.00	0.3333	0.0873	16.6024	19.635	84.56%	0.06667	0.8731	10.00	0.0207	2.349
144	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	429.00	0.3333	0.0873	16.6897	19.635	85.00%	0.06667	0.8701	9.97	0.0207	2.362
145	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	432.00	0.3333	0.0873	16.7770	19.635	85.44%	0.06667	0.8672	9.94	0.0207	2.376
146	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	435.00	0.3333	0.0873	16.8642	19.635	85.89%	0.06667	0.8642	9.90	0.0207	2.390
147	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	438.00	0.3333	0.0873	16.9515	19.635	86.33%	0.06667	0.8612	9.87	0.0207	2.405
148	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	441.00	0.3333	0.0873	17.0388	19.635	86.78%	0.06667	0.8583	9.84	0.0207	2.419
149	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	444.00	0.3333	0.0873	17.1260	19.635	87.22%	0.06667	0.8553	9.80	0.0207	2.434
150	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	447.00	0.3333	0.0873	17.2133	19.635	87.67%	0.06667	0.8524	9.77	0.0207	2.449
151	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	450.00	0.3333	0.0873	17.3006	19.635	88.11%	0.06667	0.8494	9.73	0.0207	2.464
152	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	453.00	0.3333	0.0873	17.3878	19.635	88.56%	0.06667	0.8464	9.70	0.0207	2.479

Brightwater Conveyance System - Diffuser Predesign

216-1800-00

PMX

PMX

Diffuser Design Parameters:

MGD	129.0	mgd
Enter Design Flow:	199.6	cfs
Enter Diffuser Length:	500	ft
Enter Diffuser Diameter:	5.0	ft
Enter Number of Ports:	168	
Enter Roughness Factor:	0.000300	Steel
Enter Effluent Specific Gravity:	0.9991	wastewater
Enter Effluent Kinematic Viscosity:	1.50E-05	ft2/sec
Select Total Head of End Port:	4.410	ft
Flows Matched:	199.47	cfs **YES**
Diffuser Driving Head:	5.18	ft

Port Design Parameters:

Enter Port Type (Riser or Orifice):	Orifice	
Enter Entrance Loss Coefficient:	0.52	
Enter Length of Riser:	0.0	ft
Enter Diameter of Riser:	0.33	ft
Enter Roughness Factor:	0.000300	Steel
Enter Elbow Loss Coefficient:	0.00	None
Enter Contraction Loss Coefficient:	0.00	None
Enter Jet Contraction Coefficient:	1.00	

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Port Number	Port Diameter (in)	Port Spacing (ft)	Port Depth STP Datum (ft)	Diffuser Diameter (ft)	Diffuser Slope (ft/ft)	Ambient Spec. Grav. at Port Ht.	(pa - po)/po	Distance to Upstream Port (ft)	Port Diameter (ft)	Port Area (ft2)	Cumulative Port Area (ft2)	Diffuser Area (ft2)	Cumulative Port/Diff. Area (%)	Ratio of Port to Diff. Diameter	Port Discharge (cfs)	Port Velocity (ft/sec)	Riser Moody Friction Factor	Port X Factor
153	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	456.00	0.3333	0.0873	17.4751	19.635	89.00%	0.06667	0.8435	9.67	0.0207	2.495
154	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	459.00	0.3333	0.0873	17.5624	19.635	89.44%	0.06667	0.8405	9.63	0.0207	2.510
155	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	462.00	0.3333	0.0873	17.6496	19.635	89.89%	0.06667	0.8376	9.60	0.0207	2.526
156	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	465.00	0.3333	0.0873	17.7369	19.635	90.33%	0.06667	0.8346	9.56	0.0207	2.542
157	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	468.00	0.3333	0.0873	17.8242	19.635	90.78%	0.06667	0.8317	9.53	0.0207	2.559
158	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	471.00	0.3333	0.0873	17.9114	19.635	91.22%	0.06667	0.8287	9.50	0.0207	2.575
159	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	474.00	0.3333	0.0873	17.9987	19.635	91.67%	0.06667	0.8258	9.46	0.0207	2.592
160	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	477.00	0.3333	0.0873	18.0860	19.635	92.11%	0.06667	0.8228	9.43	0.0207	2.609
161	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	480.00	0.3333	0.0873	18.1732	19.635	92.56%	0.06667	0.8199	9.40	0.0207	2.626
162	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	483.00	0.3333	0.0873	18.2605	19.635	93.00%	0.06667	0.8170	9.36	0.0207	2.643
163	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	486.00	0.3333	0.0873	18.3478	19.635	93.44%	0.06667	0.8140	9.33	0.0207	2.661
164	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	489.00	0.3333	0.0873	18.4350	19.635	93.89%	0.06667	0.8111	9.29	0.0207	2.678
165	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	492.00	0.3333	0.0873	18.5223	19.635	94.33%	0.06667	0.8082	9.26	0.0208	2.696
166	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	495.00	0.3333	0.0873	18.6096	19.635	94.78%	0.06667	0.8053	9.23	0.0208	2.715
167	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	498.00	0.3333	0.0873	18.6968	19.635	95.22%	0.06667	0.8023	9.19	0.0208	2.733
168	4.000	3.00	610.00	5.00	0.0000	1.0235	0.02442	501.00	0.3333	0.0873	18.7841	19.635	95.67%	0.06667	0.7994	9.16	0.0208	2.752

Brightwater Conveyance System - Diffuser Predesign

Diffuser Design Parameters:

ןn Flow:	199.6	cfs
ѕer Length:	500	ft
ѕer Diameter:	5.0	ft
ɔer of Ports:	168	
hness Factor:	0.000300	Steel
ːnt Specific Gravity:	0.9991	wastewater
ːnt Kinematic Viscosity:	1.50E-05	ft2/sec
l Head of End Port:	4.41	ft
hed:	199.47	cfs **YES**
ving Head:	5.18	ft

Port Design Parameters:

Enter Port Type (Riser or Orifice):	Orifice		
Enter Entrance Loss Coefficient:	0.52		
Enter Length of Riser:	0.0	ft	
Enter Diameter of Riser:	0.3	ft	
Enter Roughness Factor:	0.000300	Steel	
Enter Elbow Loss Coefficient:	0.00	None	
Enter Contraction Loss Coefficient:	0.00	None	
Enter Jet Contraction Coefficient:	1.00		0.0000

Port Coefficient of Discharge	Port Froude Number	Riser Reynolds Number	Diffuser Discharge (cfs)	Diffuser Velocity (ft/sec)	Diffuser Increment in Velocity (ft/sec)	Diffuser Velocity Head (ft)	Diffuser Reynolds Number	Diffuser Moody Friction Fact.	Head Loss Betw. Ports (ft)	Density Head Change (ft)	Dens+Frict Head Change (ft)	HGL (ft)	Velocity Head/ Total Head (ft)	EGL Total Head (ft)	Comment
0.663	19.52	3.88E+05	*1.524*	0.0776	0.0776	0.0001	2.59E+04	0.024	0.0000	0.00000	0.0000	*4.410*	0.0000	4.410	Down-
0.663	19.52	3.88E+05	3.047	0.1552	0.0776	0.0004	5.17E+04	0.021	0.0000	0.00000	0.0000	4.410	0.0001	4.410	Stream
0.663	19.52	3.88E+05	4.571	0.2328	0.0776	0.0008	7.76E+04	0.019	0.0000	0.00000	0.0000	4.410	0.0002	4.411	Port
0.663	19.52	3.88E+05	6.094	0.3103	0.0776	0.0015	1.03E+05	0.018	0.0000	0.00000	0.0000	4.410	0.0003	4.412	
0.663	19.51	3.88E+05	7.617	0.3879	0.0776	0.0023	1.29E+05	0.017	0.0000	0.00000	0.0000	4.410	0.0005	4.412	
0.663	19.51	3.88E+05	9.139	0.4655	0.0775	0.0034	1.55E+05	0.017	0.0000	0.00000	0.0000	4.410	0.0008	4.413	
0.662	19.50	3.88E+05	10.661	0.5430	0.0775	0.0046	1.81E+05	0.016	0.0000	0.00000	0.0000	4.410	0.0010	4.415	
0.662	19.50	3.88E+05	12.183	0.6205	0.0775	0.0060	2.07E+05	0.016	0.0001	0.00000	0.0001	4.410	0.0014	4.416	
0.662	19.49	3.88E+05	13.704	0.6980	0.0775	0.0076	2.33E+05	0.016	0.0001	0.00000	0.0001	4.410	0.0017	4.418	
0.662	19.48	3.88E+05	15.225	0.7754	0.0774	0.0093	2.58E+05	0.015	0.0001	0.00000	0.0001	4.410	0.0021	4.420	
0.661	19.47	3.87E+05	16.745	0.8528	0.0774	0.0113	2.84E+05	0.015	0.0001	0.00000	0.0001	4.410	0.0026	4.422	
0.661	19.47	3.87E+05	18.264	0.9302	0.0774	0.0134	3.10E+05	0.015	0.0001	0.00000	0.0001	4.410	0.0030	4.424	
0.661	19.46	3.87E+05	19.783	1.0075	0.0773	0.0158	3.36E+05	0.015	0.0001	0.00000	0.0001	4.411	0.0036	4.426	
0.660	19.45	3.87E+05	21.301	1.0848	0.0773	0.0183	3.62E+05	0.015	0.0002	0.00000	0.0002	4.411	0.0041	4.429	
0.660	19.43	3.87E+05	22.817	1.1621	0.0773	0.0210	3.87E+05	0.014	0.0002	0.00000	0.0002	4.411	0.0048	4.432	
0.660	19.42	3.86E+05	24.333	1.2393	0.0772	0.0238	4.13E+05	0.014	0.0002	0.00000	0.0002	4.411	0.0054	4.435	
0.659	19.41	3.86E+05	25.848	1.3164	0.0772	0.0269	4.39E+05	0.014	0.0002	0.00000	0.0002	4.411	0.0061	4.438	
0.659	19.40	3.86E+05	27.362	1.3935	0.0771	0.0302	4.65E+05	0.014	0.0003	0.00000	0.0003	4.411	0.0068	4.442	
0.658	19.38	3.86E+05	28.875	1.4706	0.0770	0.0336	4.90E+05	0.014	0.0003	0.00000	0.0003	4.412	0.0076	4.445	
0.658	19.37	3.85E+05	30.386	1.5476	0.0770	0.0372	5.16E+05	0.014	0.0003	0.00000	0.0003	4.412	0.0084	4.449	
0.657	19.35	3.85E+05	31.896	1.6245	0.0769	0.0410	5.41E+05	0.014	0.0003	0.00000	0.0003	4.412	0.0093	4.453	
0.656	19.33	3.85E+05	33.405	1.7013	0.0769	0.0449	5.67E+05	0.014	0.0004	0.00000	0.0004	4.413	0.0102	4.458	
0.656	19.32	3.84E+05	34.913	1.7781	0.0768	0.0491	5.93E+05	0.014	0.0004	0.00000	0.0004	4.413	0.0111	4.462	
0.655	19.30	3.84E+05	36.419	1.8548	0.0767	0.0534	6.18E+05	0.014	0.0004	0.00000	0.0004	4.413	0.0121	4.467	
0.655	19.28	3.84E+05	37.924	1.9314	0.0766	0.0579	6.44E+05	0.014	0.0005	0.00000	0.0005	4.414	0.0131	4.472	
0.654	19.26	3.83E+05	39.427	2.0080	0.0766	0.0626	6.69E+05	0.013	0.0005	0.00000	0.0005	4.414	0.0142	4.477	
0.653	19.24	3.83E+05	40.929	2.0845	0.0765	0.0675	6.95E+05	0.013	0.0005	0.00000	0.0005	4.415	0.0153	4.482	
0.652	19.22	3.82E+05	42.428	2.1609	0.0764	0.0725	7.20E+05	0.013	0.0006	0.00000	0.0006	4.415	0.0164	4.488	
0.652	19.20	3.82E+05	43.927	2.2372	0.0763	0.0777	7.46E+05	0.013	0.0006	0.00000	0.0006	4.416	0.0176	4.494	
0.651	19.17	3.81E+05	45.423	2.3134	0.0762	0.0831	7.71E+05	0.013	0.0007	0.00000	0.0007	4.417	0.0188	4.500	
0.650	19.15	3.81E+05	46.918	2.3895	0.0761	0.0887	7.97E+05	0.013	0.0007	0.00000	0.0007	4.417	0.0201	4.506	
0.649	19.13	3.81E+05	48.410	2.4655	0.0760	0.0944	8.22E+05	0.013	0.0007	0.00000	0.0007	4.418	0.0214	4.512	
0.648	19.10	3.80E+05	49.901	2.5415	0.0759	0.1003	8.47E+05	0.013	0.0008	0.00000	0.0008	4.419	0.0227	4.519	
0.647	19.07	3.80E+05	51.390	2.6173	0.0758	0.1064	8.72E+05	0.013	0.0008	0.00000	0.0008	4.419	0.0241	4.526	
0.646	19.05	3.79E+05	52.877	2.6930	0.0757	0.1126	8.98E+05	0.013	0.0009	0.00000	0.0009	4.420	0.0255	4.533	
0.645	19.02	3.78E+05	54.362	2.7686	0.0756	0.1190	9.23E+05	0.013	0.0009	0.00000	0.0009	4.421	0.0269	4.540	
0.644	18.99	3.78E+05	55.844	2.8441	0.0755	0.1256	9.48E+05	0.013	0.0010	0.00000	0.0010	4.422	0.0284	4.548	
0.643	18.97	3.77E+05	57.324	2.9195	0.0754	0.1324	9.73E+05	0.013	0.0010	0.00000	0.0010	4.423	0.0299	4.555	

Diffuser Design Parameters:

ŋn Flow:	199.6	cfs
ser Length:	500	ft
ser Diameter:	5.0	ft
ɔer of Ports:	168	
hness Factor:	0.000300	Steel
ent Specific Gravity:	0.9991	wastewater
ent Kinematic Viscosity:	1.50E-05	ft2/sec
l Head of End Port:	4.41	ft
hed:	199.47	cfs
ving Head:	5.18	ft

YES

Port Design Parameters:

Enter Port Type (Riser or Orifice):	Orifice		
Enter Entrance Loss Coefficient:	0.52		
Enter Length of Riser:	0.0	ft	
Enter Diameter of Riser:	0.3	ft	
Enter Roughness Factor:	0.000300	Steel	
Enter Elbow Loss Coefficient:	0.00	None	
Enter Contraction Loss Coefficient:	0.00	None	
Enter Jet Contraction Coefficient:	1.00		0.0000

Port Coefficient of Discharge	Port Froude Number	Riser Reynolds Number	Diffuser Discharge (cfs)	Diffuser Velocity (ft/sec)	Diffuser Increment in Velocity (ft/sec)	Diffuser Velocity Head (ft)	Diffuser Reynolds Number	Diffuser Moody Friction Fact.	Head Loss Betw. Ports (ft)	Density Head Change (ft)	Dens+Frict Head Change (ft)	HGL (ft)	Velocity Head/ Total Head (ft)	EGL Total Head (ft)	Comment
0.642	18.94	3.77E+05	58.803	2.9948	0.0753	0.1393	9.98E+05	0.013	0.0011	0.00000	0.0011	4.424	0.0315	4.563	
0.641	18.91	3.76E+05	60.278	3.0699	0.0752	0.1463	1.02E+06	0.013	0.0011	0.00000	0.0011	4.425	0.0331	4.572	
0.640	18.88	3.76E+05	61.752	3.1450	0.0750	0.1536	1.05E+06	0.013	0.0012	0.00000	0.0012	4.426	0.0347	4.580	
0.639	18.85	3.75E+05	63.223	3.2199	0.0749	0.1610	1.07E+06	0.013	0.0012	0.00000	0.0012	4.428	0.0364	4.589	
0.638	18.81	3.74E+05	64.691	3.2947	0.0748	0.1686	1.10E+06	0.013	0.0013	0.00000	0.0013	4.429	0.0381	4.597	
0.637	18.78	3.74E+05	66.157	3.3694	0.0747	0.1763	1.12E+06	0.013	0.0013	0.00000	0.0013	4.430	0.0398	4.606	
0.635	18.75	3.73E+05	67.621	3.4439	0.0745	0.1842	1.15E+06	0.013	0.0014	0.00000	0.0014	4.431	0.0416	4.616	
0.634	18.72	3.72E+05	69.081	3.5183	0.0744	0.1922	1.17E+06	0.013	0.0015	0.00000	0.0015	4.433	0.0434	4.625	
0.633	18.68	3.72E+05	70.539	3.5925	0.0743	0.2004	1.20E+06	0.013	0.0015	0.00000	0.0015	4.434	0.0452	4.635	
0.632	18.65	3.71E+05	71.995	3.6667	0.0741	0.2088	1.22E+06	0.013	0.0016	0.00000	0.0016	4.436	0.0471	4.645	
0.630	18.61	3.70E+05	73.448	3.7407	0.0740	0.2173	1.25E+06	0.013	0.0016	0.00000	0.0016	4.437	0.0490	4.655	
0.629	18.57	3.70E+05	74.897	3.8145	0.0738	0.2259	1.27E+06	0.013	0.0017	0.00000	0.0017	4.439	0.0509	4.665	
0.627	18.54	3.69E+05	76.344	3.8882	0.0737	0.2348	1.30E+06	0.013	0.0018	0.00000	0.0018	4.441	0.0529	4.675	
0.626	18.50	3.68E+05	77.788	3.9617	0.0735	0.2437	1.32E+06	0.013	0.0018	0.00000	0.0018	4.442	0.0549	4.686	
0.625	18.46	3.67E+05	79.229	4.0351	0.0734	0.2528	1.35E+06	0.012	0.0019	0.00000	0.0019	4.444	0.0569	4.697	
0.623	18.42	3.67E+05	80.667	4.1083	0.0732	0.2621	1.37E+06	0.012	0.0020	0.00000	0.0020	4.446	0.0589	4.708	
0.622	18.38	3.66E+05	82.102	4.1814	0.0731	0.2715	1.39E+06	0.012	0.0020	0.00000	0.0020	4.448	0.0610	4.720	
0.620	18.34	3.65E+05	83.534	4.2543	0.0729	0.2810	1.42E+06	0.012	0.0021	0.00000	0.0021	4.450	0.0632	4.731	
0.619	18.30	3.64E+05	84.963	4.3271	0.0728	0.2907	1.44E+06	0.012	0.0022	0.00000	0.0022	4.452	0.0653	4.743	
0.617	18.26	3.63E+05	86.388	4.3997	0.0726	0.3006	1.47E+06	0.012	0.0022	0.00000	0.0022	4.454	0.0675	4.755	
0.616	18.22	3.63E+05	87.810	4.4721	0.0724	0.3106	1.49E+06	0.012	0.0023	0.00000	0.0023	4.457	0.0697	4.767	
0.614	18.18	3.62E+05	89.229	4.5444	0.0723	0.3207	1.51E+06	0.012	0.0024	0.00000	0.0024	4.459	0.0719	4.780	
0.612	18.14	3.61E+05	90.645	4.6165	0.0721	0.3309	1.54E+06	0.012	0.0025	0.00000	0.0025	4.461	0.0742	4.792	
0.611	18.09	3.60E+05	92.057	4.6884	0.0719	0.3413	1.56E+06	0.012	0.0025	0.00000	0.0025	4.464	0.0765	4.805	
0.609	18.05	3.59E+05	93.465	4.7602	0.0717	0.3518	1.59E+06	0.012	0.0026	0.00000	0.0026	4.466	0.0788	4.818	
0.607	18.00	3.58E+05	94.871	4.8317	0.0716	0.3625	1.61E+06	0.012	0.0027	0.00000	0.0027	4.469	0.0811	4.831	
0.606	17.96	3.57E+05	96.272	4.9031	0.0714	0.3733	1.63E+06	0.012	0.0028	0.00000	0.0028	4.472	0.0835	4.845	
0.604	17.91	3.56E+05	97.670	4.9743	0.0712	0.3842	1.66E+06	0.012	0.0028	0.00000	0.0028	4.474	0.0859	4.859	
0.602	17.87	3.55E+05	99.065	5.0453	0.0710	0.3953	1.68E+06	0.012	0.0029	0.00000	0.0029	4.477	0.0883	4.872	
0.601	17.82	3.55E+05	100.456	5.1162	0.0708	0.4064	1.71E+06	0.012	0.0030	0.00000	0.0030	4.480	0.0907	4.887	
0.599	17.77	3.54E+05	101.843	5.1868	0.0706	0.4177	1.73E+06	0.012	0.0031	0.00000	0.0031	4.483	0.0932	4.901	
0.597	17.72	3.53E+05	103.226	5.2573	0.0705	0.4292	1.75E+06	0.012	0.0031	0.00000	0.0031	4.486	0.0957	4.915	Up-
0.595	17.68	3.52E+05	104.606	5.3275	0.0703	0.4407	1.78E+06	0.012	0.0032	0.00000	0.0032	4.489	0.0982	4.930	Stream
0.593	17.63	3.51E+05	105.982	5.3976	0.0701	0.4524	1.80E+06	0.012	0.0033	0.00000	0.0033	4.493	0.1007	4.945	Port
0.591	17.58	3.50E+05	107.353	5.4675	0.0699	0.4642	1.82E+06	0.012	0.0034	0.00000	0.0034	4.496	0.1032	4.960	
0.589	17.53	3.49E+05	108.721	5.5371	0.0697	0.4761	1.85E+06	0.012	0.0035	0.00000	0.0035	4.499	0.1058	4.975	
0.587	17.48	3.48E+05	110.085	5.6066	0.0695	0.4881	1.87E+06	0.012	0.0036	0.00000	0.0036	4.503	0.1084	4.991	
0.586	17.43	3.47E+05	111.446	5.6759	0.0693	0.5002	1.89E+06	0.012	0.0036	0.00000	0.0036	4.506	0.1110	5.007	

Brightwater Conveyance System - Diffuser Predesign

Diffuser Design Parameters:			Port Design Parameters:		
n Flow:	199.6	cfs	Enter Port Type (Riser or Orifice):	Orifice	
er Length:	500	ft	Enter Entrance Loss Coefficient:	0.52	
er Diameter:	5.0	ft	Enter Length of Riser:	0.0	ft
er of Ports:	168		Enter Diameter of Riser:	0.3	ft
hness Factor:	0.000300	Steel	Enter Roughness Factor:	0.000300	Steel
nt Specific Gravity:	0.9991	wastewater	Enter Elbow Loss Coefficient:	0.00	None
nt Kinematic Viscosity:	1.50E-05	ft2/sec	Enter Contraction Loss Coefficient:	0.00	None
			Enter Jet Contraction Coefficient:	1.00	0.0000
l Head of End Port:	4.41	ft			
hed:	199.47	cfs	YES		
ving Head:	5.18	ft			

Port Coefficient of Discharge	Port Froude Number	Riser Reynolds Number	Diffuser Discharge (cfs)	Diffuser Velocity (ft/sec)	Diffuser Increment in Velocity (ft/sec)	Diffuser Velocity Head (ft)	Diffuser Reynolds Number	Diffuser Moody Friction Fact.	Head Loss Betw. Ports (ft)	Density Head Change (ft)	Dens+Frict Head Change (ft)	HGL (ft)	Velocity Head/ Total Head (ft)	EGL Total Head (ft)	Comment
0.584	17.37	3.46E+05	112.802	5.7449	0.0691	0.5125	1.91E+06	0.012	0.0037	0.00000	0.0037	4.510	0.1136	5.022	
0.582	17.32	3.45E+05	114.154	5.8138	0.0689	0.5248	1.94E+06	0.012	0.0038	0.00000	0.0038	4.514	0.1163	5.039	
0.580	17.27	3.44E+05	115.501	5.8824	0.0686	0.5373	1.96E+06	0.012	0.0039	0.00000	0.0039	4.517	0.1189	5.055	
0.578	17.22	3.43E+05	116.845	5.9509	0.0684	0.5499	1.98E+06	0.012	0.0040	0.00000	0.0040	4.521	0.1216	5.071	
0.575	17.16	3.41E+05	118.185	6.0191	0.0682	0.5626	2.01E+06	0.012	0.0041	0.00000	0.0041	4.525	0.1243	5.088	
0.573	17.11	3.40E+05	119.520	6.0871	0.0680	0.5754	2.03E+06	0.012	0.0042	0.00000	0.0042	4.529	0.1270	5.105	
0.571	17.05	3.39E+05	120.851	6.1549	0.0678	0.5882	2.05E+06	0.012	0.0043	0.00000	0.0043	4.534	0.1298	5.122	
0.569	17.00	3.38E+05	122.178	6.2225	0.0676	0.6012	2.07E+06	0.012	0.0044	0.00000	0.0044	4.538	0.1325	5.139	
0.694	23.17	2.64E+05	123.213	6.2752	0.0527	0.6115	2.09E+06	0.012	0.0044	0.00000	0.0044	4.542	0.1346	5.154	
0.692	23.11	2.63E+05	124.246	6.3278	0.0526	0.6218	2.11E+06	0.012	0.0045	0.00000	0.0045	4.547	0.1367	5.168	
0.689	23.06	2.63E+05	125.276	6.3802	0.0525	0.6321	2.13E+06	0.012	0.0046	0.00000	0.0046	4.551	0.1389	5.183	
0.687	23.00	2.62E+05	126.303	6.4326	0.0523	0.6425	2.14E+06	0.012	0.0046	0.00000	0.0046	4.556	0.1410	5.198	
0.685	22.94	2.61E+05	127.328	6.4848	0.0522	0.6530	2.16E+06	0.012	0.0047	0.00000	0.0047	4.560	0.1432	5.213	
0.683	22.88	2.61E+05	128.351	6.5369	0.0521	0.6635	2.18E+06	0.012	0.0048	0.00000	0.0048	4.565	0.1453	5.229	
0.681	22.83	2.60E+05	129.371	6.5888	0.0519	0.6741	2.20E+06	0.012	0.0049	0.00000	0.0049	4.570	0.1475	5.244	
0.679	22.77	2.59E+05	130.388	6.6406	0.0518	0.6847	2.21E+06	0.012	0.0049	0.00000	0.0049	4.575	0.1497	5.259	
0.677	22.71	2.59E+05	131.403	6.6923	0.0517	0.6954	2.23E+06	0.012	0.0050	0.00000	0.0050	4.580	0.1519	5.275	
0.675	22.65	2.58E+05	132.415	6.7438	0.0515	0.7062	2.25E+06	0.012	0.0051	0.00000	0.0051	4.585	0.1540	5.291	
0.673	22.59	2.57E+05	133.424	6.7952	0.0514	0.7170	2.27E+06	0.012	0.0052	0.00000	0.0052	4.590	0.1562	5.307	
0.671	22.53	2.57E+05	134.431	6.8465	0.0513	0.7279	2.28E+06	0.012	0.0052	0.00000	0.0052	4.595	0.1584	5.323	
0.669	22.47	2.56E+05	135.435	6.8976	0.0511	0.7388	2.30E+06	0.012	0.0053	0.00000	0.0053	4.600	0.1606	5.339	
0.666	22.41	2.55E+05	136.436	6.9487	0.0510	0.7497	2.32E+06	0.012	0.0054	0.00000	0.0054	4.605	0.1628	5.355	
0.664	22.35	2.55E+05	137.435	6.9995	0.0509	0.7608	2.33E+06	0.012	0.0055	0.00000	0.0055	4.611	0.1650	5.372	
0.662	22.29	2.54E+05	138.431	7.0503	0.0507	0.7718	2.35E+06	0.012	0.0055	0.00000	0.0055	4.616	0.1672	5.388	
0.660	22.23	2.53E+05	139.425	7.1008	0.0506	0.7830	2.37E+06	0.012	0.0056	0.00000	0.0056	4.622	0.1694	5.405	
0.658	22.17	2.53E+05	140.415	7.1513	0.0505	0.7941	2.38E+06	0.012	0.0057	0.00000	0.0057	4.627	0.1716	5.422	
0.655	22.11	2.52E+05	141.403	7.2016	0.0503	0.8053	2.40E+06	0.012	0.0058	0.00000	0.0058	4.633	0.1738	5.439	
0.653	22.05	2.51E+05	142.389	7.2518	0.0502	0.8166	2.42E+06	0.012	0.0058	0.00000	0.0058	4.639	0.1760	5.456	
0.651	21.99	2.50E+05	143.371	7.3018	0.0500	0.8279	2.43E+06	0.012	0.0059	0.00000	0.0059	4.645	0.1782	5.473	
0.649	21.93	2.50E+05	144.351	7.3517	0.0499	0.8393	2.45E+06	0.012	0.0060	0.00000	0.0060	4.651	0.1805	5.490	
0.646	21.87	2.49E+05	145.328	7.4015	0.0498	0.8507	2.47E+06	0.012	0.0061	0.00000	0.0061	4.657	0.1827	5.507	
0.644	21.80	2.48E+05	146.302	7.4511	0.0496	0.8621	2.48E+06	0.012	0.0062	0.00000	0.0062	4.663	0.1849	5.525	
0.642	21.74	2.48E+05	147.274	7.5006	0.0495	0.8736	2.50E+06	0.012	0.0062	0.00000	0.0062	4.669	0.1871	5.543	
0.640	21.68	2.47E+05	148.242	7.5499	0.0493	0.8851	2.52E+06	0.012	0.0063	0.00000	0.0063	4.675	0.1893	5.560	
0.637	21.62	2.46E+05	149.208	7.5991	0.0492	0.8967	2.53E+06	0.012	0.0064	0.00000	0.0064	4.682	0.1915	5.578	
0.635	21.55	2.45E+05	150.171	7.6482	0.0490	0.9083	2.55E+06	0.012	0.0065	0.00000	0.0065	4.688	0.1938	5.596	
0.633	21.49	2.45E+05	151.131	7.6971	0.0489	0.9199	2.57E+06	0.012	0.0066	0.00000	0.0066	4.694	0.1960	5.614	
0.631	21.43	2.44E+05	152.089	7.7458	0.0488	0.9316	2.58E+06	0.012	0.0066	0.00000	0.0066	4.701	0.1982	5.633	

Diffuser Design Parameters:

ɲn Flow:	199.6	cfs
ɜer Length:	500	ft
ɜer Diameter:	5.0	ft
ɔer of Ports:	168	
hness Factor:	0.000300	Steel
ɛnt Specific Gravity:	0.9991	wastewater
ɛnt Kinematic Viscosity:	1.50E-05	ft2/sec
l Head of End Port:	4.41	ft
hed:	199.47	cfs **YES**
ving Head:	5.18	ft

Port Design Parameters:

Enter Port Type (Riser or Orifice):	Orifice	
Enter Entrance Loss Coefficient:	0.52	
Enter Length of Riser:	0.0	ft
Enter Diameter of Riser:	0.3	ft
Enter Roughness Factor:	0.000300	Steel
Enter Elbow Loss Coefficient:	0.00	None
Enter Contraction Loss Coefficient:	0.00	None
Enter Jet Contraction Coefficient:	1.00	0.0000

Port Coefficient of Discharge	Port Froude Number	Riser Reynolds Number	Diffuser Discharge (cfs)	Diffuser Velocity (ft/sec)	Diffuser Increment in Velocity (ft/sec)	Diffuser Velocity Head (ft)	Diffuser Reynolds Number	Diffuser Moody Friction Fact.	Head Loss Betw. Ports (ft)	Density Head Change (ft)	Dens+Frict Head Change (ft)	HGL (ft)	Velocity Head/ Total Head (ft)	EGL Total Head (ft)	Comment
0.628	21.37	2.43E+05	153.043	7.7944	0.0486	0.9434	2.60E+06	0.012	0.0067	0.00000	0.0067	4.708	0.2004	5.651	
0.626	21.30	2.43E+05	153.995	7.8429	0.0485	0.9551	2.61E+06	0.012	0.0068	0.00000	0.0068	4.714	0.2026	5.670	
0.624	21.24	2.42E+05	154.944	7.8912	0.0483	0.9670	2.63E+06	0.012	0.0069	0.00000	0.0069	4.721	0.2048	5.688	
0.621	21.17	2.41E+05	155.890	7.9394	0.0482	0.9788	2.65E+06	0.012	0.0070	0.00000	0.0070	4.728	0.2070	5.707	
0.619	21.11	2.40E+05	156.833	7.9875	0.0480	0.9907	2.66E+06	0.012	0.0071	0.00000	0.0071	4.735	0.2092	5.726	
0.617	21.05	2.40E+05	157.774	8.0353	0.0479	1.0026	2.68E+06	0.012	0.0071	0.00000	0.0071	4.742	0.2114	5.745	
0.614	20.98	2.39E+05	158.711	8.0831	0.0477	1.0145	2.69E+06	0.012	0.0072	0.00000	0.0072	4.749	0.2136	5.764	
0.612	20.92	2.38E+05	159.646	8.1307	0.0476	1.0265	2.71E+06	0.012	0.0073	0.00000	0.0073	4.756	0.2158	5.783	
0.610	20.85	2.37E+05	160.577	8.1781	0.0475	1.0385	2.73E+06	0.012	0.0074	0.00000	0.0074	4.764	0.2180	5.802	
0.607	20.79	2.37E+05	161.506	8.2254	0.0473	1.0506	2.74E+06	0.012	0.0075	0.00000	0.0075	4.771	0.2202	5.822	
0.605	20.72	2.36E+05	162.432	8.2726	0.0472	1.0627	2.76E+06	0.012	0.0075	0.00000	0.0075	4.779	0.2224	5.841	
0.602	20.66	2.35E+05	163.355	8.3196	0.0470	1.0748	2.77E+06	0.012	0.0076	0.00000	0.0076	4.786	0.2246	5.861	
0.600	20.59	2.35E+05	164.275	8.3665	0.0469	1.0869	2.79E+06	0.012	0.0077	0.00000	0.0077	4.794	0.2267	5.881	
0.598	20.53	2.34E+05	165.192	8.4132	0.0467	1.0991	2.80E+06	0.012	0.0078	0.00000	0.0078	4.801	0.2289	5.901	
0.595	20.46	2.33E+05	166.107	8.4597	0.0466	1.1113	2.82E+06	0.012	0.0079	0.00000	0.0079	4.809	0.2311	5.921	
0.593	20.40	2.32E+05	167.018	8.5062	0.0464	1.1235	2.84E+06	0.012	0.0080	0.00000	0.0080	4.817	0.2332	5.941	
0.591	20.33	2.32E+05	167.926	8.5524	0.0463	1.1358	2.85E+06	0.012	0.0081	0.00000	0.0081	4.825	0.2354	5.961	
0.588	20.27	2.31E+05	168.832	8.5985	0.0461	1.1481	2.87E+06	0.012	0.0081	0.00000	0.0081	4.833	0.2375	5.981	
0.586	20.20	2.30E+05	169.734	8.6445	0.0460	1.1604	2.88E+06	0.012	0.0082	0.00000	0.0082	4.841	0.2397	6.002	
0.583	20.14	2.29E+05	170.634	8.6903	0.0458	1.1727	2.90E+06	0.012	0.0083	0.00000	0.0083	4.850	0.2418	6.022	
0.581	20.07	2.29E+05	171.531	8.7360	0.0457	1.1851	2.91E+06	0.012	0.0084	0.00000	0.0084	4.858	0.2439	6.043	
0.579	20.00	2.28E+05	172.424	8.7815	0.0455	1.1974	2.93E+06	0.012	0.0085	0.00000	0.0085	4.866	0.2461	6.064	
0.576	19.94	2.27E+05	173.315	8.8269	0.0454	1.2098	2.94E+06	0.012	0.0086	0.00000	0.0086	4.875	0.2482	6.085	
0.574	19.87	2.26E+05	174.203	8.8721	0.0452	1.2223	2.96E+06	0.012	0.0086	0.00000	0.0086	4.883	0.2503	6.106	
0.571	19.81	2.26E+05	175.088	8.9172	0.0451	1.2347	2.97E+06	0.012	0.0087	0.00000	0.0087	4.892	0.2524	6.127	
0.569	19.74	2.25E+05	175.970	8.9621	0.0449	1.2472	2.99E+06	0.012	0.0088	0.00000	0.0088	4.901	0.2545	6.148	
0.566	19.67	2.24E+05	176.849	9.0068	0.0448	1.2597	3.00E+06	0.012	0.0089	0.00000	0.0089	4.909	0.2566	6.169	
0.564	19.61	2.23E+05	177.725	9.0515	0.0446	1.2722	3.02E+06	0.012	0.0090	0.00000	0.0090	4.918	0.2587	6.191	
0.562	19.54	2.23E+05	178.598	9.0959	0.0445	1.2847	3.03E+06	0.012	0.0091	0.00000	0.0091	4.927	0.2607	6.212	
0.559	19.47	2.22E+05	179.468	9.1402	0.0443	1.2973	3.05E+06	0.012	0.0092	0.00000	0.0092	4.936	0.2628	6.234	
0.557	19.41	2.21E+05	180.335	9.1844	0.0442	1.3098	3.06E+06	0.012	0.0092	0.00000	0.0092	4.946	0.2648	6.255	
0.554	19.34	2.20E+05	181.200	9.2284	0.0440	1.3224	3.08E+06	0.012	0.0093	0.00000	0.0093	4.955	0.2669	6.277	
0.552	19.28	2.20E+05	182.061	9.2723	0.0439	1.3350	3.09E+06	0.012	0.0094	0.00000	0.0094	4.964	0.2689	6.299	
0.550	19.21	2.19E+05	182.919	9.3160	0.0437	1.3476	3.11E+06	0.012	0.0095	0.00000	0.0095	4.974	0.2710	6.321	
0.547	19.14	2.18E+05	183.774	9.3596	0.0436	1.3603	3.12E+06	0.012	0.0096	0.00000	0.0096	4.983	0.2730	6.343	
0.545	19.08	2.17E+05	184.627	9.4030	0.0434	1.3729	3.13E+06	0.012	0.0097	0.00000	0.0097	4.993	0.2750	6.366	
0.542	19.01	2.17E+05	185.476	9.4462	0.0433	1.3856	3.15E+06	0.012	0.0098	0.00000	0.0098	5.002	0.2770	6.388	
0.540	18.94	2.16E+05	186.323	9.4893	0.0431	1.3983	3.16E+06	0.012	0.0099	0.00000	0.0099	5.012	0.2790	6.410	

Brightwater Conveyance System - Diffuser Predesign

Diffuser Design Parameters:

ņn Flow:	199.6	cfs
ser Length:	500	ft
ser Diameter:	5.0	ft
ɔer of Ports:	168	
hness Factor:	0.000300	Steel
ent Specific Gravity:	0.9991	wastewater
ent Kinematic Viscosity:	1.50E-05	ft2/sec
l Head of End Port:	4.41	ft
hed:	199.47	cfs **YES**
ving Head:	5.18	ft

Port Design Parameters:

Enter Port Type (Riser or Orifice):	Orifice		
Enter Entrance Loss Coefficient:	0.52		
Enter Length of Riser:	0.0	ft	
Enter Diameter of Riser:	0.3	ft	
Enter Roughness Factor:	0.000300	Steel	
Enter Elbow Loss Coefficient:	0.00	None	
Enter Contraction Loss Coefficient:	0.00	None	
Enter Jet Contraction Coefficient:	1.00		0.0000

Port Coefficient of Discharge	Port Froude Number	Riser Reynolds Number	Diffuser Discharge (cfs)	Diffuser Velocity (ft/sec)	Diffuser Increment in Velocity (ft/sec)	Diffuser Velocity Head (ft)	Diffuser Reynolds Number	Diffuser Moody Friction Fact.	Head Loss Betw. Ports (ft)	Density Head Change (ft)	Dens+Frict Head Change (ft)	HGL (ft)	Velocity Head/ Total Head (ft)	EGL Total Head (ft)	Comment
0.537	18.88	2.15E+05	187.166	9.5323	0.0430	1.4109	3.18E+06	0.012	0.0099	0.00000	0.0099	5.022	0.2810	6.433	
0.535	18.81	2.14E+05	188.007	9.5751	0.0428	1.4236	3.19E+06	0.012	0.0100	0.00000	0.0100	5.032	0.2829	6.456	
0.533	18.75	2.14E+05	188.844	9.6178	0.0427	1.4364	3.21E+06	0.012	0.0101	0.00000	0.0101	5.042	0.2849	6.478	
0.530	18.68	2.13E+05	189.679	9.6603	0.0425	1.4491	3.22E+06	0.012	0.0102	0.00000	0.0102	5.052	0.2868	6.501	
0.528	18.61	2.12E+05	190.511	9.7026	0.0424	1.4618	3.23E+06	0.012	0.0103	0.00000	0.0103	5.062	0.2888	6.524	
0.525	18.55	2.11E+05	191.339	9.7448	0.0422	1.4746	3.25E+06	0.012	0.0104	0.00000	0.0104	5.073	0.2907	6.547	
0.523	18.48	2.10E+05	192.165	9.7869	0.0421	1.4873	3.26E+06	0.012	0.0105	0.00000	0.0105	5.083	0.2926	6.570	
0.521	18.42	2.10E+05	192.988	9.8288	0.0419	1.5001	3.28E+06	0.012	0.0105	0.00000	0.0105	5.093	0.2945	6.593	
0.518	18.35	2.09E+05	193.808	9.8705	0.0418	1.5129	3.29E+06	0.012	0.0106	0.00000	0.0106	5.104	0.2964	6.617	
0.516	18.29	2.08E+05	194.625	9.9122	0.0416	1.5256	3.30E+06	0.012	0.0107	0.00000	0.0107	5.115	0.2983	6.640	
0.513	18.22	2.07E+05	195.439	9.9536	0.0415	1.5384	3.32E+06	0.012	0.0108	0.00000	0.0108	5.125	0.3002	6.664	
0.511	18.15	2.07E+05	196.250	9.9949	0.0413	1.5512	3.33E+06	0.012	0.0109	0.00000	0.0109	5.136	0.3020	6.687	
0.509	18.09	2.06E+05	197.058	10.0361	0.0412	1.5640	3.35E+06	0.012	0.0110	0.00000	0.0110	5.147	0.3039	6.711	
0.506	18.02	2.05E+05	197.863	10.0771	0.0410	1.5768	3.36E+06	0.012	0.0111	0.00000	0.0111	5.158	0.3057	6.735	
0.504	17.96	2.05E+05	198.666	10.1180	0.0409	1.5896	3.37E+06	0.012	0.0112	0.00000	0.0112	5.169	0.3075	6.759	
0.502	17.89	2.04E+05	199.465	10.1587	0.0407	1.6025	3.39E+06	0.012	0.0112	7.44870	7.4600	5.180	0.3093	6.783	